

Medical gas pipeline systems

Operational management

Health Technical Memorandum 2022

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About this series

Health Technical Memoranda (HTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare

They are applicable to new and existing sites, and are for use at various stages during the inception, design, construction, refurbishment and maintenance of a building.

Executive summary

This volume of Health Technical Memorandum (HTM) 2022 looks at issues of operational management. It covers such issues as statutory requirements, functional responsibilities, operational policy, operational procedures, training and communications, cylinder management, general safety, maintenance and risk assessment – control of exposure to anaesthetic agents, giving definitions and working practices throughout.

This volume is intended for use by operational managers, engineers, quality controllers, technicians, finance officers and other professionals involved in the day-to-day running of an MGPS.

The primary objective of this volume is to ensure the provision of safe and reliable MGPSs and their efficient operation and use. This objective will only be achieved if the medical and nursing users, and estates staff participate in the introduction of an operational policy designed to minimise the hazards likely to arise from misuse of the system.

A MGPS is installed to provide a safe, convenient and cost effective system for the provision of medical gases to the clinical and nursing staff at the point of use. It reduces the problems associated with the use of gas cylinders such as safety, portage, storage and noise.

The guidance given in this HTM should be followed for all new installations and refurbishment or upgrading of existing installations.

It is not necessary to apply the guidance retrospectively unless patient or staff safety would be compromised. In this case, the guidance given in this HTM should be followed.

Existing installations should be assessed for compliance with this HTM. A plan for upgrading the existing system should be prepared taking account of the priority for patient safety. Managers will need to liaise with medical colleagues and take account of other guidance published by the Department of Health in order to assess the system for technical shortcomings.

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1.0 Scope

General

1.1 This volume of Health Technical Memorandum (HTM) 2022 covers the operational management and maintenance of systems for the supply by pipeline of:

- a. medical oxygen,
- b. nitrous oxide,
- c. nitrous oxide/oxygen mixture (50% v/v),
- d. nitric oxide (currently 1000 vpm in nitrogen),
- e. medical compressed air for both respirable applications and surgical tools (at 400 kPa and 700 kPa respectively),
- f. oxygen/carbon dioxide mixture (5% CO₂),
- g. medical vacuum;
- h. waste anaesthetic gas scavenging systems (AGSS).

1.2 Throughout this volume, the phrase 'Medical Gas Pipeline Systems' (MGPS) will be used as a generic term to describe these systems.

1.3 The guidance in this volume applies to all MGPS installed in healthcare premises.

1.4 An MGPS is intended to be a safe, convenient and cost-effective alternative to the use of "portable" cylinders, portable compressors and portable suction units, providing gas or vacuum for clinical needs without the associated problems of portage, noise and space wastage.

1.5 The guidance given in this volume should be followed for all new installations and refurbishment or upgrading of existing installations.

1.6 It is not necessary to apply the guidance retrospectively unless patient or staff safety would be compromised. In this case, the guidance given in this volume should be followed.

1.7 Existing installations should be assessed for compliance with this volume. A plan for upgrading the existing system should be prepared, taking account of the priority for patient safety. Managers will need to liaise with medical colleagues and take account of the latest guidance published by the Department of Health in order to assess the system for technical shortcomings.

1.8 This volume also contains details of the design equipment and operational parameters of systems which form the basis for Model Engineering Specification C11. This specification is intended for the procurement of an MGPS. As technology develops, this HTM and C11 will be revised from time-to-time, but not necessarily simultaneously. Whichever document is the most current takes precedence.

1.9 Whenever appropriate, British Standards specifications should be used.

Operational management

1.10 This volume of HTM 2022 covers such issues as statutory requirements, functional responsibilities, operational policy, operational procedures, training and communications, cylinder management, general safety, maintenance and risk assessment – control of exposure to anaesthetic agents, giving definitions and working practices throughout.

1.11 This volume is intended for use by operational managers, engineers, quality controllers (QCs), technicians, finance officers and other professionals involved in the day-to-day running of an MGPS.

1.12 The primary objective of this volume is to ensure the provision of safe and reliable MGPS and their efficient operation and use. This objective will only be achieved if the medical and nursing users and estates staff participate in the introduction of an operational policy designed to minimise the hazards likely to arise from misuse of the system.

Other guidance

1.13 Guidance on provision of MGPS is given in the Health Building Notes.

2.0 Functional overview

Basic description of an MGPS

2.1 An MGPS comprises a source of supply, pipeline distribution system, terminal units (to which the user connects and disconnects medical equipment) and a warning/alarm system.

2.2 Systems are provided for oxygen (O₂), nitrous oxide (N₂O), nitrous oxide/oxygen (N₂O/O₂) mixture, medical air (MA4), nitric oxide (NO), oxygen/carbon dioxide (O₂/CO₂) mixture at 400 kPa for respirable applications and air at 700 kPa (SA7) for surgical tool applications, and medical vacuum at a pressure of 400 mm Hg (53 kPa) below atmospheric pressure. Anaesthetic gas scavenging (AGS) is also provided where nitrous oxide is used for anaesthetic purposes, but not when provided for analgesic purposes.

2.3 A schematic diagram of a typical system is shown in Figure 1.

2.4 Details of the quality requirements for medical gases are given in Chapter 2 of 'Design considerations'. These requirements are summarised as follows:

- a. medical gases supplied from cylinder or liquid sources should comply with the appropriate European Pharmacopoeia (Ph Eur) monograph;
- b. medical air and pressure swing adsorber (PSA) systems should comply with the requirements given in Table 1 of 'Design considerations'.

2.5 For oxygen systems the source of supply can be bulk liquid oxygen in a vacuum insulated evaporator (VIE), liquid or gaseous cylinders, or an oxygen concentrator (PSA) system. When cylinder supply systems are used, the source of supply comprises a primary and a secondary bank/group of cylinders which automatically change over to ensure continuity of supply.

2.6 An oxygen concentrator (PSA) system may be used to supply an oxygen pipeline system, even though the percentage concentration of oxygen is lower than that derived from liquid or gaseous sources, typically 94% or higher.

2.7 Nitric oxide, nitrous oxide, nitrous oxide/oxygen mixture and oxygen/carbon dioxide mixture supply systems are usually supplied from a medical gas manifold system, in two banks. When full, nitrous oxide cylinders contain or hold liquid and gaseous product with a liquid/gaseous boundary and they must be used upright. Nitrous oxide can also be supplied in liquid cylinders or VIEs. Nitrous oxide/oxygen mixture could also be supplied by means of nitrous oxide and oxygen mixing systems, similar to those used for the production of synthetic air.

2.8 For medical air systems for respirable use, the source of supply can be either a medical gas manifold system or a medical compressor system, or an oxygen and nitrogen mixing system (referred to as synthetic air). When air powered ventilators are used regularly, the consumption of air is high and cylinder supply systems are not recommended.

Throughout this volume, the phrase 'Design considerations' is used as a generic term to describe the 'Design, installation, validation and verification' volume of HTM 2022

2.0 Functional overview

2.9 Emergency/reserve manifold systems are provided for all gases and medical air for respiratory application, except for nitric oxide.

2.10 Air or nitrogen for surgical tools is required at 700 kPa. The supply can be provided by either a small automatic manifold system or a small dedicated compressed air system. No reserve supply is required since the surgical air is not used in a life-support role. A free-standing cylinder complete with regulator should be available in the event of system failure.

It is also possible to use nitrogen for surgical power tools, particularly when nitrogen is available on the site for the production of synthetic air

2.11 A non-user adjustable pressure control unit is required to maintain pressure over the range of flows required for different tools. The control unit can be installed at the supply system or locally within the theatre control panel, be mounted separately or be incorporated into theatre multi-purpose fittings.

2.12 Medical vacuum is provided by means of a central vacuum plant. The vacuum system should always be used in conjunction with vacuum control units which include vacuum jars. In the event of inadvertent contamination of the pipeline systems resulting from vacuum jars overflowing, immediate action is required to clean the system before any fluids etc dry out. The procedure for cleaning vacuum systems is given in Chapter 6 "Operational procedures" .

2.13 Medical gases and vacuum are distributed throughout the hospital via the pipeline distribution system to provide gas (and vacuum) at the terminal units. Terminal units may be wall-mounted or installed within medical supply units, for example operating room fittings, bed-head trunking and walling fittings which include other facilities such as nurse-call systems, connections for patient monitoring, electrical services, audio systems, etc.

2.14 The pipeline distribution system also includes area valve service units (AVSUs). These permit isolation of certain parts of the system for servicing or repair. They are also intended for use by the user, that is a nurse or clinician, in an emergency. For example, in the event of a fire in a ward requiring patient evacuation, or system damage to the extent that serious gas loss occurred, the valve should be turned off to prevent further gas loss.

2.15 Warning and alarm systems are provided to give information to staff responsible for the operation of the MGPS, changing cylinders, responding to plant faults, and to medical staff responsible for the administration of medical gases and clinical users.

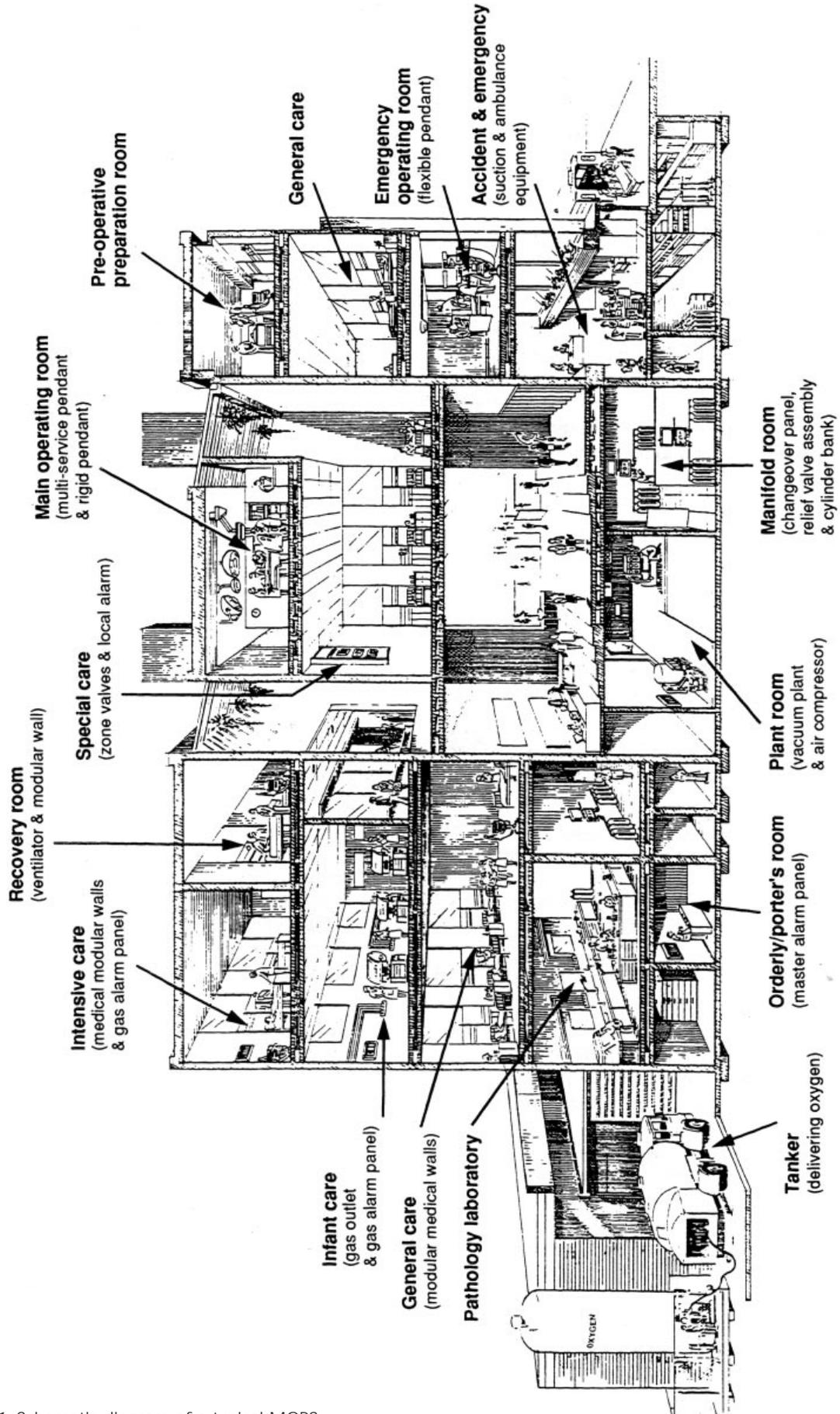


Figure 1 Schematic diagram of a typical MGPS

3.0 Statutory requirements

Statutory requirements

3.1 It is the responsibility of the owners and occupiers of premises, general managers and chief executives, to ensure that their premises and the activities carried out within them comply with all statutes.

The following are the most important statutory requirements relevant to MGPS:

- a. Health and Safety at Work etc Act 1974 (SI 1039: 1978); Health and Safety at Work Northern Ireland Order 1978;
- b. Management of Health and Safety at Work Regulations 1992 (SI 1992/2051); SR 459: 1992 Management of Health and Safety at Work Regulations (Northern Ireland) 1992;
- c. Workplace (Health, Safety and Welfare) Regulations 1992 (SI 1992/3004); Workplace (Health, Safety and Welfare) Regulations (Northern Ireland) 1993 (SI (NI) 1993/87);
- d. Provision and Use of Work Equipment Regulations 1992 (SI 1992/2932); Provision and Use of Work Equipment Regulations (Northern Ireland) 1992 (SI (NI) 19/1993);
- e. Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (SI 3163: 1985); SR 247: 1996 Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (Northern Ireland) 1986;
- f. Control of Substances Hazardous to Health (COSHH) Regulations 1994 (SI 3246: 1994); SR 374 Control of Substances Hazardous to Health (COSHH) Regulations (NI) 1990; Control of Substances Hazardous to Health (COSHH) Regulations Amendment (NI) 1992, (SI41: 1993);
- g. Pressure Systems and Transportable Gas Containers Regulations 1989 (SI 1989 No 2169); SI 471: 1991 Pressure Systems and Transportable Gas Containers Regulations 1991;
- h. Highly Flammable Liquid and Liquefied Petroleum Gases Regulations (SI 1972 No 917); Highly Flammable Liquid and Liquefied Petroleum Gases Regulations (NI) 1975 (SR 256);
- j. Medicines Act 1968 (this applies in NI);
- k. Manual Handling Operations Regulations 1992 (SI 1992/2793); Manual Handling Operations Regulations (Northern Ireland) 1992 SI (NI) 535/1992;
- m. Personal Protective Equipment at Work Regulations 1992 (SI 1992/3139); Personal Protective Equipment at Work Regulations (Northern Ireland) 1993 (SI 1993);
- n. Electrical Equipment (Safety) Regulations 1994, SI 3260;
- p. Electromagnetic Compatibility Regulations 1992 (SI 1992/2372).

The equivalent body in Northern Ireland is the Department of Economic Development, Health and Safety Inspectorate

Health and Safety at Work etc Act 1974

3.2 Employers have a general duty under this Act, so far as is reasonably practicable, to ensure the health, safety and welfare of their employees, residents and visitors to their premises. These duties are legally enforceable and the Health & Safety Executive have successfully prosecuted occupiers of premises under this statute. It is incumbent upon both owners and occupiers of premises to ensure that there is a management regime for the proper design, installation and operational management of plant, equipment and systems.

Management of Health and Safety at Work Regulations 1992

3.3 The core requirements of the regulations are that employers make a systematic assessment of risks in relation to the health and safety of their employees and others arising from work activities.

Workplace (Health, Safety and Welfare) Regulations 1992

3.4 Most of these regulations are to ensure a safe physical working environment, for example adequate lighting, ventilation, space to perform maintenance tasks and adequate access routes.

Provision and Use of Work Equipment Regulations 1992

3.5 The aim of these regulations is to ensure safe work equipment and safety in its use. It includes "any machine, appliance, apparatus or tool", and clearly covers medical gas pipeline installations and equipment. It applies to all equipment for use from 1 January 1993.

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995

3.6 The regulations (RIDDOR) impose duties to report accidents resulting in death or major injury. For example, exposure of patients to the wrong medical gas from a pipeline, hazards of sudden release of gas under pressure, burns from cryogenic liquid.

Manual Handling Operation Regulations 1992

3.7 These regulations impose health and safety requirements with respect to handling loads by human effort.

3.8 They apply to the handling of medical gas cylinders whether used for portable applications or connected to a manifold system. The mass of the load

3.0 Statutory requirements

is not the only source of risk; the temperature and other factors should also be taken into account, for example, cryogenic liquid containers.

3.9 Management is responsible for assessing all the risks to avoid injury.

Personal Protective Equipment at Work Regulations 1992

3.10 Managers should assess the risk associated with the operation of MGPS, for example the provision of gloves for handling cylinders and cryogenic liquid containers and eye and face protection when changing medical vacuum filters.

Electromagnetic Compatibility Regulations 1992

3.11 Medical gas pipeline equipment, such as plant items and alarm systems, will have to meet standards for emission of, and immunity to, electromagnetic disturbance.

Detailed guidance on requirements in healthcare premises may be found in HTM 2014 – ‘Abatement of electrical interference’.

COSHH Regulations

3.12 These regulations apply to substances that have been classified as being very toxic, toxic, harmful, corrosive or irritant. Specific duties are placed upon employers and employees in relation to these substances.

3.13 The specific responsibilities for employers include assessment, protection and control, monitoring, health surveillance and information and training.

3.14 The COSHH regulations apply to MGPS in that inhalation anaesthetic agents and Nitric Oxide (NO) are substances to which Occupational Exposure Standards (OESs) have been assigned.

OESs for nitrous oxide, enflurane, halothane and isoflurane came into effect on 1 January 1995. The current issue of EH40 should be consulted.

3.15 It is the manager’s responsibility to ensure that a proper system of assessment, protection and monitoring is implemented in order to comply with the regulations. The guidance given in Chapter 11 “Risk assessment – control of exposure to anaesthetic agents” and the ‘Design considerations’ volume of this HTM in respect of anaesthetic gas scavenging systems (AGSS) should be implemented as a matter of priority.

Pressure Systems and Transportable Gas Containers Regulations 1989

3.16 These regulations apply to all steam systems and systems in which the gas pressure exceeds 0.5 bar g; they therefore apply to MGPS.

3.17 Where existing plant and systems are operating satisfactorily and can be shown to be in a safe condition, then only minor changes may be required in order to comply with the overall objective of these regulations. This will be the case where MGPS comply with the recommendations in this HTM.

NHS Estates has published a Health Guidance Note, ‘The Pressure Systems and Transportable Gas Containers Regulations 1989’, which explains the application of the regulations within the NHS. ISBN 0 11 321674 2.

The term "competent person" has been used in this HTM to refer to the fitter who carries out the installation or modification to the MGPS. For the purposes of clarity, this person (fitter) is referred to as the competent person (MGPS). This is not the same person referred to as a competent person for the purposes of the regulations, who is normally a chartered engineer with specialist expertise and experience, although in certain cases an incorporated engineer may carry out the duties of a competent person.

3.18 The regulations define and extend the role of a "competent person". The competent person is required to draw up or to certify a written scheme of examination. This should cover the whole system, not merely the pressure vessels.

3.19 A written scheme of examination as specified by the 'Pressure Systems and Transportable Gas Containers Regulations 1989' should be drawn up for all MGPS. For new installations the consulting engineers may prepare the written scheme. An appropriate competent person should implement the written scheme and carry out the examinations required. For pressure vessels, this would normally be carried out by an appropriate insurance company with specialist expertise in this field.

3.20 Requirements for pressure vessels are included in these regulations.

Highly Flammable Liquid and Liquid Petroleum Gas Regulations 1972

3.21 These regulations and the Home Office Fire Prevention Guide No 4 'Safe Use and Storage of Liquefied Petroleum Gas in Residential Premises' cover all uses of highly flammable liquids and liquefied petroleum gas (LPG). The Health and Safety Executive Guidance Note CS 4 'The Keeping of LPG in Cylinders and Similar Containers' should also be consulted.

3.22 The regulations give specific requirements for the use and storage of flammable liquids and LPG. Chapter 8 "Cylinder management" also gives details of cylinder handling and storage.

Medicines Act

3.23 Medical gases are classified as medicinal products under the Medicines Act and are therefore subject to the same procurement and quality procedures as all other medicinal products.

3.24 The quality controller (QC) is responsible for quality control of all medicinal products and this will include medical gases.

3.25 Medical gases and vacuum should not be used for non-medical purposes other than as a power source for medical equipment and also for testing medical equipment.

4.0 Functional responsibilities

General

4.1 Since the first edition of this HTM, there have been profound changes in the management philosophy of the NHS. Many hospitals have become self-governing trusts, many general practices have become fund-holders, and there is a trend towards deregulation and contracting-out of services.

4.2 The approach chosen for this HTM is to identify the distinct functions that need to be exercised and the responsibilities that go with them. The titles given here are therefore generic. They describe the individual's role in connection with MGPS, but are not intended to be prescriptive job titles for terms of employment. Indeed, some of the personnel referred to may not be resident staff but people employed by outside bodies and working on contract, for example competent persons (MGPS).

4.3 Some staff will have other responsibilities unconnected with MGPS and in some cases the same individual may take on more than one role.

4.4 In all cases, however, it is essential to identify an **authorised person** who is responsible for the day-to-day management of the MGPS.

4.5 **The philosophy of this HTM is to invest the authorised person (MGPS) with the responsibility for seeing that the MGPS is operated safely and efficiently. Only the authorised person (MGPS) can decide whether an MGPS should be taken into or out of use.**

In order to avoid confusion with other authorised persons, such as the authorised person for high voltage installations, the authorised person for the MGPS will be referred to as the authorised person (MGPS) throughout this HTM.

Previous editions of HTM 22 defined a responsible officer. As a result of the changes to the management structure within the NHS, the duties of the responsible officer are now carried out by the chief executive, estates manager or the authorised person (MGPS) as appropriate. It is therefore considered that the role of the responsible officer is no longer required.

Management

4.6 Management is defined as the owner, occupier, employer, general manager, chief executive, or other person (MGPS) who is ultimately accountable for the safe operation of the premises.

Key personnel

4.7 The following are the key personnel who have specific responsibilities within the operational policy:

- a. executive manager;
- b. estates manager;
- c. authorised person (MGPS);
- d. competent person (MGPS);
- e. quality controller (QC);
- f. designated medical or nursing officer.

Executive manager

4.8 The **executive manager** is defined as the person with ultimate management responsibility, including allocation of resources and the appointment of personnel, for the organisation in which the MGPS are installed.

4.9 Depending on the nature of the organisation, this role may be filled by the general manager, chief executive, laboratory director or other person of similar authority.

4.10 The formal responsibility for the MGPS rests with an **executive manager**, although the authorised person (MGPS) retains effective responsibility for day-to-day management of the MGPS.

4.11 The executive manager is responsible for the implementation of the operational policy for the MGPS. He/she should ensure that the operational policy clearly defines the roles and responsibilities of all personnel who may be involved in the use, installation and maintenance of the MGPS. The executive manager is also responsible for monitoring the implementation of the policy.

4.12 The executive manager may delegate specific responsibilities to key personnel; the extent of such delegation should be clearly set out in the operational policy, together with the arrangements for liaison and monitoring.

Estates management

4.13 The estates management includes responsibility for the integrity of the MGPS. There may be one or more authorised and competent persons (MGPS) with clear line management responsibility.

4.14 Estates management should include monitoring the implementation of the operational policy for MGPS. In particular, the MGPS should comply with the requirements of this HTM and all work should be carried out in accordance, where possible, with the permit-to-work procedures.

Authorised person (MGPS)

4.15 The authorised person (MGPS) is defined as that person designated by the executive manager to be responsible for the day-to-day management of the MGPS at a particular site or sites. This includes the issue of permits and the operation of the permit-to-work procedure. The principal responsibilities of the authorised person (MGPS) in respect of the permit-to-work procedure are set out in paragraph 6.41.

4.16 All authorised persons (MGPS) should be appointed in writing by the chief executive or general manager on the recommendation of a chartered engineer who has specialist knowledge of MGPS. An individual assessment of the suitability of the potential authorised person (MGPS) will normally be required before such a recommendation can be made.

4.17 It is extremely unlikely that specialist contractors would be able to carry out the day-to-day duties of an authorised person (MGPS) and they should, therefore, not be appointed as authorised persons (MGPS), except under exceptional circumstances.

4.0 Functional responsibilities

4.18 Procedures using permits for the authorisation of work requires the fullest co-operation of all staff and their acceptance of the responsibilities involved. The authorised person (MGPS) should take the lead in co-ordinating the work and explaining fully the extent and duration of any disruption to the service. He/she should also ensure that all contractors follow the procedures set out in the permit.

4.19 The authorised person (MGPS) is responsible for ensuring that:

- a. all designated nursing officers likely to be involved are advised of the estimated duration of the work and the interruption to the MGPS;
- b. all terminal units affected, that is, out of service, are appropriately labelled.

4.20 On a large site, there could be several authorised persons (MGPS). In this case, the executive manager should appoint one as the senior authorised person (MGPS) with overall responsibility for the site. In any case, arrangements should be made to ensure that an authorised person (MGPS) is always available during holidays and other absences of the other authorised person(s) (MGPS).

4.21 The authorised person (MGPS) is required to liaise closely with other professionals in various disciplines, and consequently the appointment should be made known in writing to all interested parties. He/she should have direct contact with the quality controller (QC), users and other key personnel.

4.22 The authorised person (MGPS) is responsible for assessing the competency of all competent persons (MGPS) employed directly by the estates department and maintaining a list of registered competent persons (MGPS).

4.23 The authorised person (MGPS) is responsible for ensuring that work is carried out only by approved specialist contractors registered to BS EN ISO 9000 with scope of registration defined as design, installation, commissioning and maintenance of MGPS as appropriate. Evidence of current registration should be by sight of the correct certificate of registration.

The concept of the existing Quality Assurance BSI Schedule QAS 3720.1/206 is currently under review. Further guidance will be given when appropriate.

Competent person (MGPS)

4.24 The competent person (MGPS) is the maintenance person or fitter who carries out the work on the MGPS. A list of his/her responsibilities and duties are set out in the 'Permit-to-work' section of Chapter 6 "Operational procedures". The competent person (MGPS) should have received appropriate training and should be on a list of competent persons (MGPS).

4.25 The competent person (MGPS) may be a member of a specialist contractor's staff or may be a member of the estates department. Where the competent person (MGPS) is a member of the estates department, the authorised person (MGPS) is responsible for assessing the competency of the competent person (MGPS) with respect to work on the MGPS. Where the competent person (MGPS) is a member of a contractor's staff, the contractor is responsible for assessing the competence of the competent staff and maintaining a register of competent persons (MGPS).

*The **competent person** as defined in the Pressure Systems and Transportable Gas Containers Regulations 1989 is **not** the same person as the **competent person (MGPS)** defined in this HTM. The former is a chartered engineer responsible for drawing up a scheme of examination for the system. The latter is the maintenance person or fitter who will carry out installation or modifications.*

Quality controller (QC)

4.26 The person designated as the quality controller (QC) is responsible for the quality control of the medical gases at the terminal unit and plant, such as medical air compressors, oxygen concentrators and mixing plants. The authorised person (MGPS) will need to liaise with the QC before an MGPS can be taken into use; the specific tests and requirements are set out in Chapter 15 of 'Design considerations'.

4.27 The QC should have received training on the verification and validation of MGPS and be familiar with the requirements of this HTM.

Designated medical or nursing officer

4.28 The designated medical or nursing officer is the person in each department with whom the authorised person (MGPS) liaises on any matters affecting the MGPS and who would give permission for a planned interruption to the supply.

4.29 It is essential that there is liaison between the medical and nursing staff who use the MGPS and the authorised person (MGPS) in order to ensure that the MGPS is appropriate to their needs.

4.30 The authorised person (MGPS) should be consulted prior to the purchase of any medical equipment that will be connected to the MGPS.

4.31 The designated officer should give permission for any interruption to the MGPS and should sign the appropriate part of the permit. Normally the permission of the designated medical officer is required, but in certain circumstances such permission may be given by the designated nurse. The operational policy should clearly set out the requirements for such permission (see Chapter 5).

4.32 The designated officer is responsible for ensuring that all staff are aware of the interruption to the MGPS and which terminal units cannot be used.

4.33 There should ideally be a designated officer for every department; the operational policy should list the designated persons and the arrangements for cover due to absences of the designated officers.

4.34 The designated officer acts as the focal point for communications related to the MGPS and advises on any special requirements for his/her department relating to MGPS, such as provision of emergency cylinders.

4.35 The designated officer would normally carry out the appropriate action in the event of an emergency; such actions should be set out in the operational policy.

4.36 All designated officers should have received training on the MGPS relevant to their departments and on the action to be taken in the event of an emergency. The operational policy should set out the training requirements.

5.0 Operational policy

General

5.1 The executive manager is responsible for the overall operational policy and its implementation.

5.2 The Chapter headings given in this volume of HTM 2022 and subsequent Chapter guidance should enable an operational policy to be prepared. Separate policies or procedures are sometimes prepared to supplement the operational policy. It is acknowledged that some trusts have separate procedures that are referenced within the operational policy under the control of specific departments, that is, cylinder management under the control of the pharmacy department.

Operational considerations

5.3 The operational policy should ensure that users are aware of the capacity of the system and any particular limitations, for example a 400 kPa medical air system supplied from a cylinder manifold system is unlikely to sustain the use of a number of respiratory ventilators. Nursing and medical staff should also be aware of the purpose of alarm systems and of the course of action to be taken in the event of an emergency alarm occurring. They should be similarly familiar with the purpose of area value service units (AVSUs) and how to use them in an emergency.

5.4 MGPS provide gases at terminal units of a microbiological quality which is adequate for virtually all applications. There may be exceptional circumstances, for example patients receiving immuno-suppressive drugs, where additional precautions may be required. This can be most readily achieved by incorporating an appropriate bacteria retentive filter in the breathing system. Similarly, changes in patient ventilation regimes can affect the capacity of systems. For example, continuous positive airway pressure (CPAP) ventilation can lead to significant consumption of oxygen.

5.5 Medical gases should not be used for non-medical purposes other than as a test gas for medical equipment; except under specific circumstances as defined in paragraph 2.6 of 'Design considerations'.

5.6 Medical air should be used as the power source for medical equipment such as ventilators or venturis; oxygen should not be used, except in an emergency where an appropriate medical air system is not available. The routine use of oxygen as a driving gas is to be avoided.

5.7 Medical gases supplied from cylinder or liquid sources comply with the European Pharmacopoeia (Ph Eur). Pressure swing adsorber (PSA) systems comply with the requirements given in Chapter 6 of 'Design considerations'. All other gases or medical gas mixtures will comply with the product licence specification held by the gas supplier.

5.8 Where PSA systems are installed, medical staff will need to take account of the reduced oxygen concentration when using medical equipment, and be aware of possible increases in concentration if the emergency/reserve manifold is in operation.

5.9 Staff responsible for plant operation should be aware of the activities necessary to ensure the continued safe operation of the system and what action should be taken in an emergency. The authorised person (MGPS) in particular should take a lead in explaining to users the function of the system and will have to be adequately trained and informed about the system. (See also paragraphs 7.1–7.7, on training.)

5.10 Where gas blenders are used at point of use, for example with patient ventilators, the manufacturer's instructions should be followed with regard to operation and maintenance, to prevent contamination of a pipeline in the event of equipment malfunction. Further details are given in Chapter 10 "Maintenance".

BS ISO 11195 1995 'Gas mixers for medical use – stand-alone gas mixers' was developed to avoid this problem.

5.11 Some older types of blending equipment can allow back flow from one pipeline to another, for example leading to oxygen enrichment of medical air systems, or reduction of oxygen content in oxygen pipelines. When not in use, blenders should be disconnected.

5.12 There is growing interest in the concept of mixing liquid oxygen and liquid nitrogen on-site for the provision of medical synthetic air. This system is not yet developed in the UK healthcare market, but is currently in use in the USA. Given the concerns about inner city pollution, this concept may offer considerable advantages over conventional compressor systems.

5.13 In some hospital ward areas medical gas equipment is installed within enclosures or behind decorative panels to provide a more domestic environment. In these cases it is essential that identification is maintained so that staff are aware that equipment is available for patient use. Staff should also ensure that gas supplies are turned off, blenders are disconnected and suction jars removed and cleaned before any equipment is concealed.

5.14 Users of 700 kPa surgical systems should be aware of the stored energy of gas in the connecting assembly (hose) and should take care to avoid the hazard of rapid ejection of probes when disconnecting tools.

5.15 Portable suction units should be used in areas where there is a possibility that the vacuum system could become contaminated. Such areas would include infectious diseases units. The need for portable suction units should be discussed with the control of infection officer.

5.16 Before any maintenance work is carried out on any medical equipment, including portable suction units, the equipment should be appropriately decontaminated and the procedures in Appendix II should be followed.

5.17 Any work involving alterations, extensions or maintenance work on the system should be subject to the permit-to-work procedure set out in Chapter 6 "Operational procedures", which should be under the control of the authorised person (MGPS).

5.18 The responsibility for gas cylinders should be clearly defined in the operational policy. This would include the training of personnel in the correct procedures for cylinder handling, storage and transportation. The procedures in Chapter 8 "Cylinder management" should be followed.

5.19 Pharmacy staff have a responsibility for monitoring the quality of all gases delivered, including PSA, compressed air and synthetic air. It may be appropriate to include warning systems within the pharmacy department.

Emergency procedures

5.20 The operational policy should set out the procedures to be followed in the event of an emergency. This should include the following:

- a. reporting an incident;
- b. action to be taken, for example turning off isolation valves, use of portable emergency cylinders;
- c. liaison with other staff and departments;
- d. calling out contractors.

5.21 All alarm systems should be clearly labelled and all staff should be trained in the appropriate action to be taken in the event that an alarm is initiated.

Power supply failure

5.22 Power supply failure, changeover to emergency and reinstatement of normal supply may cause control systems on plant items, such as compressors and manifolds, to change to a default condition. When such changeover occurs, staff should ensure that, for example, manifold cylinder contents accord with the alarm signal status, and in the case of compressor and PSA systems the duty and stand-by conditions are as selected.

Record drawings

5.23 The estates department should have accurate and up-to-date drawings of the MGPS showing main sections and branches, departments served, control valves, terminal units and alarm systems for each medical gas service. These drawings should be readily available on site for use by any authorised person (MGPS). Their location should be known by all authorised persons (MGPS). Each isolating valve should be individually identified by a unique reference number. The appropriate reference number, corresponding to that shown on the drawings, should be displayed at or on each isolating valve. The drawing should indicate the type and make of terminal units.

5.24 A schematic diagram of the installation is usually helpful.

5.25 When additions or alterations are to be made to existing installations by a contractor, the authorised person (MGPS) should provide an adequate number of prints from the master drawing as agreed with the contractor. On completion of the work, the contractor should return to the authorised person (MGPS) at least one copy of an amended print, indicating pipework alterations etc. The authorised person (MGPS) should arrange for the master MGPS drawing to be updated. In some cases it may be part of the contract agreement that an "amended as fitted" drawing is provided by the contractor to then replace the original master drawing.

Up-to-date drawings and records are required under the Pressure Systems and Transportable Gas Containers Regulations 1989

Locking of valves and plantrooms for MGPS

5.26 All valves on the MGPS, except those in plantrooms, should be secured in such a way that they can normally be locked in the closed or open position. In the case of those valves which may have to be operated in an emergency,

the locking system should be capable of being overridden. Medical gas plantrooms should be kept locked, except when work is actually in progress in them.

5.27 plantrooms containing medical gas cylinders should be kept locked, with a prominently-displayed notice indicating the location of the spare key.

5.28 For access in the event of an emergency see paragraph 8.89.

5.29 The valves in the liquid oxygen installation need not be kept locked. The gate to the liquid oxygen installation should be kept locked and an indestructible and clear notice stating the location of the key should be securely fixed to each gate of the installation. The fire brigade should be informed of the location of the key (see paragraphs 8.86–8.88).

5.30 The procedure in the operational policy for keeping keys should be followed.

Monitoring of the operational policy

5.31 The executive manager is responsible for monitoring the operational policy to ensure that it is being properly implemented. This should be carried out on a regular basis, and the procedure for such monitoring should be set out in the operational policy.

5.32 The responsibility for monitoring specific aspects is delegated to the appropriate key personnel. For example, the responsibility for monitoring the implementation of the permit-to-work procedure would normally be delegated to the estate manager. The details of such delegation should be set out in the operational policy.

Contractors

5.33 All contractors should comply with the trust or hospital safety policy. This should be clearly stated in the operational policy.

5.34 Work on MGPS should only be carried out by specialist firms registered to BS EN ISO 9000 with scope of registration defined as design, installation, commissioning and maintenance of MGPS as appropriate. Evidence of current registration should be by sight of the correct certificate of registration.

5.35 The operational policy should set out the responsibilities for monitoring the work of contractors. This would normally be co-ordinated by the authorised person (MGPS). The procedures for calling out a contractor, particularly in the event of a fault or an emergency, should be set out in the operational policy.

The concept of the existing Quality Assurance BSI Schedule, QAS 3720.1/206.1A is currently under review. Further guidance will be given when appropriate.

Medical equipment purchase

5.36 The authorised person (MGPS) should be consulted prior to the purchase of any medical equipment which will be connected to the MGPS. This is to ensure that the MGPS has sufficient capacity and can deliver the required flows at the specified pressures. It is particularly important that the authorised person (MGPS) should be consulted before any new equipment,

5.0 Operational policy

such as patient ventilators, is connected to the medical air 400 kPa system, to ensure that the system capacity is not exceeded. Certain ventilators can also have a significant effect on the capacity of oxygen systems, particularly those operating under continuous positive airway pressure (CPAP).

5.37 The policy should state the procedures to be followed and the personnel who need to be consulted before a new item of medical equipment is connected to the MGPS.

6.0 Operational procedures

Permit-to-work procedure

Introduction

6.1 Safety rules and procedures for MGPS are necessary to ensure that the integrity and performance of the system is maintained.

6.2 The purpose of the permit issued under this permit-to-work system is to safeguard the integrity of the MGPS. It is not intended as a permit to protect the safety of staff. In some cases there may be additional safety procedures to be followed under the Health and Safety at Work etc Act 1974 or the health authority's safety policy or COSHH.

6.3 A permit-to-work should always be issued before any work is carried out on the MGPS. The purpose of such a permit is to identify the work to be carried out and to provide documentary evidence that a system is only taken back into use when all tests have been satisfactorily completed.

6.4 The permit-to-work procedure is one of the responsibilities of the estates department. The authorised person (MGPS) who has day-to-day responsibility for the MGPS will be responsible for the implementation of the permit-to-work procedure.

Scope

General

6.5 The permit-to-work procedure is applicable to the servicing, repair, alteration and extension of existing MGPS within a hospital, and any action, such as the closure of an isolating valve, which restricts the supply. This means that permits should also be used before any major item of central plant, for example manifold, control panel, compressor, or vacuum pump (including any stand-by plant), is isolated prior to servicing, repair or overhaul. A specimen permit form is given in Figure 2.

6.6 The permit will remain in force until the work is completed and the MGPS is taken back into use, in accordance with the procedure.

Emergencies

6.7 In the event of an emergency such as a fire or a major leak, a doctor or nurse should isolate the affected section by closing the emergency isolating valves or area valve service units (AVSUs). He/she should notify the authorised person (MGPS) as soon as possible.

6.8 The emergency procedure set out in the hospital authority's operational policy should be followed.

Medical Gas Pipeline Systems - PERMIT-TO-WORK FORM - in accordance with HTM 2022
 While copy to CP, Risk copy to QC
 Original (Yellow) copy retained in book. Book retained by management. Permit No. **95/0026**

HOSPITALS TRUST

PART 1
 The Authorized Person to indicate the level of hazard: Hazard level: _____
 The Authorized Person to indicate the scope of the proposed work: (circle as appropriate)
 Medical Gas System: Oxygen N₂O N₂O/CO₂ MAA SA7 Vacuum AQS
 Areas affected: _____
 Authorized Person (MGPFS): Name (print): _____ Signature: _____ Date: _____
 The above system may be taken out of service for a period of approximately: _____ hours/days
 from (date and level): _____
 Designated medical or nursing officer: Name (print): _____ Signature: _____ Date: _____
 Title: _____

PART 2 WORK TO BE CARRIED OUT
 Specification no: _____ Drawing no: _____ Date: _____
 The system(s) are isolated as follows at: _____

 The following work should be carried out: _____

NO OTHER WORK SHALL BE CARRIED OUT
 Other permits to work in use are: Permit no: _____ Issued to: _____ Date: _____
 Authorized Person (MGPFS): Name (print): _____ Signature: _____ Date: _____
 AP taking over: Name (print): _____ Signature: _____ Date: _____

PART 3
 I accept responsibility for carrying out the work as indicated above.
 No attempt will be made by me or by any person under my control to work on any other part of the system.
 I am fully conversant with the relevant fire and safety requirements.

Competent Person (MGPFS): Name (print): _____ Signature: _____ Date: _____
 CP taking over: Name (print): _____ Signature: _____ Date: _____

PART 4
 I declare that I have completed the work identified in Part 2 to the standards required.
 I have advised the Authorized Person (MGPFS) of all work carried out
 and provided details of the installation.

Competent Person (MGPFS): Name (print): _____ Signature: _____ Date: _____

PART 5
 I declare that the work described in Part 2 is now complete.
 The following tests have been satisfactorily carried out in accordance with HTM 2022 Validation and Verification.
 The appropriate test forms have been completed in accordance with HTM 2022 Good Practice Guide.
 The Authorized Person (MGPFS) to initial the appropriate spaces. If not carried out, mark box 'N/D'.

Pipeline carcass tests	AP Initial	Pipeline system tests	AP Initial	Pipeline system tests	AP Initial
Labelling & marking		Leakage		NIST connectors	
Steering & Supports		Area valve service units		System performance	
Leakage		Cross-connection		Supply systems tests	
Cross-connection		Flow & pressure drop		Pressure safety valves	
Quality (after system test)	AP Initial	Mechanical function		Warning systems	
Particulate contamination		Gas specificity		As-fitted drawings	

Authorized Person (MGPFS): Name (print): _____ Signature: _____ Date: _____

PART 6 FOR COMPLETION AFTER MEDIUM OR LOW HAZARD WORKS ONLY
 Identity tests have been satisfactorily carried out for medium hazard work only.

Identity tests	AP Initial	Identity tests	AP Initial	Identity tests	AP Initial
Oxygen		N ₂ O/CO ₂		SA7	
N ₂ O		MAA		Vacuum	

All other tests have been satisfactorily carried out in accordance with HTM 2022 Validation and Verification and appropriate test forms (HTM 2022 Good Practice Guide) have been completed. The system may be taken into use.
 Authorized Person (MGPFS): Name (print): _____ Signature: _____ Date: _____

PART 7 FOR COMPLETION AFTER HIGH HAZARD WORKS ONLY
 Identity and quality tests have been satisfactorily carried out in accordance with HTM 2022 Validation and Verification.
 The appropriate test forms have been completed in accordance with HTM 2022 Good Practice Guide.
 The AP (MGPFS) and the QC should initial the spaces as appropriate. If a test is not carried out, mark box 'N/D'.

Identity tests	AP Initial	QC Initial	Quality tests	AP Initial	QC Initial
Oxygen			Drygas		
N ₂ O			N ₂ O		
N ₂ O/CO ₂			N ₂ O/CO ₂		
MAA			MAA		
SA7			SA7		
Vacuum					

The system may be taken into use
 Authorized Person (MGPFS): Name (print): _____ Signature: _____ Date: _____
 Quality Controller (QC): Name (print): _____ Signature: _____ Date: _____

PART 8
 I declare that all aspects of the work have been explained to me, including any modifications since the original instructions were approved. I hereby accept the system back into service and I will undertake to advise at the appropriate staff that the service has been reinstated.
 Designated medical or nursing officer: Name (print): _____ Signature: _____ Date: _____
 Title: _____

Figure 2 Specimen permit-to-work form

Work by contractors

6.9 Permits should be issued to any of a contractor's competent staff and artisans who are to be engaged in work on the MGPS. Contracts should be placed only with firms who are appropriately registered as discussed in paragraphs 4.23 and 5.34. Further guidance on contractors' competence etc is given in the "Preparation of a maintenance contract" section of Chapter 10 "Maintenance".

6.10 Neither the department nor the health authority should be expected to test the competence of the contractor's staff. The contractor should maintain a register of competent persons.

Routine changing of cylinders

6.11 Permits are not necessary for the routine replacement of cylinders on manifolds nor for the recharging of vacuum insulated evaporators (VIEs), provided there is no danger of the supply being disrupted when these tasks are undertaken.

Planned preventative maintenance (PPM) work

6.12 A permit should be issued for all PPM work on the MGPS. This includes all examinations where no interruption to the service is anticipated.

Where visual inspections have been carried out historically and will continue to be carried out by the trust's in-house staff, existing documentary evidence of work completion may be an alternative to the permit as agreed with the authorised person (MGPS).

Levels of hazard

6.13 Whenever work is to be carried out on the MGPS, it is assigned a level of hazard dependent upon the nature of the work. The authorised person (MGPS) assesses the hazard level at the time of preparing the permit and if in doubt he/she will assess the hazard at the higher level. The higher the hazard the greater the care required in the re-commissioning procedure. Three levels of hazard are defined as follows:

- a. **high hazard work:** work on any part of the MGPS that requires cutting or brazing. Cross-connection, performance, identity and quality tests will be required before the MGPS is taken back into use;
- b. **medium hazard work:** work on two or more adjacent terminal units (excluding vacuum) which do not comply with BS 5682. Performance and identity tests will be required before the MGPS is taken back into use;
- c. **low hazard work:** work on terminal unit (in addition to vacuum) which comply with BS 5682. A performance test only will be required before MGPS is taken back into use.

6.14 Terminal units which comply with BS 5682 comprise components which are gas-specific and it is therefore not possible to miss-assemble the terminal unit in such a way that the wrong gas is delivered. This is the principle on which the levels of hazard are based.

6.0 Operational procedures

6.15 The gas-specific feature can be achieved by means of indexing pins, gas-specific shapes etc. During reassembly the gas-specific features should be checked to ensure they have not been damaged.

6.16 Terminal units complying with BS 5682 include an automatic isolating valve and some earlier terminal units include a manual valve.

6.17 When working on individual terminal units fitted with an integral isolating valve or check valve (which operates when the socket assembly is removed), it is not necessary to interrupt the supply to other adjacent terminal units.

6.18 Terminal unit termination blocks should not be left unattended with the socket currently removed unless a blocking plate has been attached.

6.19 Outlets which have been disconnected from their supply (cut and capped supplies) should be removed or fitted with full disc-size prohibition labels. Long runs which may hold stagnant gas and cannot be purged should be avoided.

Duties

6.20 A summary of the duties and responsibilities of personnel involved is given in Chapter 4 "Functional responsibilities".

Permission for interruption or restriction of supply

6.21 Permission should be obtained before work is carried out to allow designated medical or nursing officers adequate time to move patients etc, except in an emergency.

6.22 The authorised person (MGPS) should describe to the designated medical or nursing officer the extent to which the MGPS will be restricted or interrupted while the work is in progress and should indicate the level of hazard involved. He/she should obtain agreement for this restriction or interruption by means of a signature on Part 1 of the permit. He/she should also assist as necessary, to ensure that a service is maintained whilst the MGPS is disrupted.

Liaison with medical and nursing officers and quality controller

6.23 The procedures allow work to proceed on an MGPS only with the knowledge of the QC (for high hazard work only), and the permission of either the designated medical or nursing officer would be competent to grant permission in all cases where the authorised person (MGPS) indicates in Part 1 of the permit-to-work that the work is of a low hazard nature. No work of a high hazard nature should normally be permitted without the permission of the designated medical officer.

6.24 The permission of the designated medical officer should normally be obtained before any interruption is caused to the supply of a gas affecting more than one ward or department of a hospital. This approval may be given by a designated nursing officer in circumstances to be agreed locally and subject to periodic review by those concerned. These agreements should be recorded in the operational policy, as described in Chapter 5 "Operational policy".

When terminal units to BS 5682 are dismantled for repair or replacement of the main working components it is not possible to re-assemble them with parts designed for another gas service, except by a wilful act on the part of the fitter, for example by cutting or removing non-interchangeability keys. It is thus not possible to supply gas to a patient by inserting a probe into the incorrect terminal unit, for example an assembly comprising an oxygen pipe termination block and a nitrous oxide outlet. Parts can become damaged or omitted during assembly and continuing vigilance is required. Some early terminal units not complying with BS 5682 do not include service isolating or check valves.

6.25 There should be general agreement between the authorised person (MGPS), and the medical and nursing officers on the length of advance notice which will normally be required before interruptions of the MGPS may be made. This might typically be 48 hours for fully pre-planned work. These agreements should be recorded in the operational policy.

Isolation of plant and pipeline system

6.26 The authorised person (MGPS) is responsible for witnessing the isolation and for making safe the plant or system to be worked on.

6.27 No section of an MGPS should be worked on, or pressure tested, unless it is adequately isolated from any section in use or available for use.

6.28 Physical isolation, by means of a break point at the “supply” end of the section to be worked on, is essential, except in the case of work on terminal units only. An AVSU may be used for this purpose, as described in ‘Design considerations’. The procedure for installing an additional branch is given in Appendix II.

Limits of authorisation

6.29 There should be no commencement of work on any MGPS until the designated medical officer or designated nursing officer has given written permission, on the permit, for the work to take place.

6.30 Permits should only be issued immediately before work is to start and they should only be issued to a competent person (MGPS).

6.31 The permit should provide concise and accurate information about when and where it is safe and when and where it is dangerous to work. It should provide a clear statement of the work to be done. The estimated time for completion should also be given, but this is for guidance purposes only, and should not prejudice the completion of the work in complete safety.

6.32 The scope of the actual work done should be limited to that described in Part 2 of the permit and no one should change the description of the work. In the event of a change in the programme of work, the permit should be cancelled and a new one issued. This should be cross-referenced to the original Part 1 approval. If the change is no longer covered by Part 1 approval, a completely new permit should be initiated.

6.33 A competent person (MGPS) accepting a permit is, from that moment, responsible for the safe conduct of the work within the limits of the permit, but the work will be subject to the usual supervision by the authorised person (MGPS) and proper commissioning procedure on completion. The competent person (MGPS) should not allow himself/herself to be persuaded into breaking the conditions of the permit. He/she should make himself/herself fully conversant with its terms and requirements, and should give sufficient and clear instructions to persons working under him/her.

Scope of permit

6.34 The extent of the work specified in Part 2 of the permit should not be amended. If changes to the work are required, a new permit should be issued.

6.0 Operational procedures

6.35 Any errors may be corrected and initialled.

6.36 The permit remains in force until Part 8 is completed.

Permit issuing authority and control of permit books

6.37 The issuing authority should be the authorised person (MGPS). Permits may only be issued by an authorised person (MGPS).

6.38 A new book of permits should not be taken into use until the old book is completely used and accounted for.

6.39 The permits should be consecutively numbered.

Forms of permit

6.40 The permit is to be in book form, numbered consecutively, with two coloured tear-out copies for use as follows:

- a. copy 1 to the competent person (MGPS);
- b. copy 2 to the QC;
- c. original retained in book, which remains with the senior authorised person (MGPS) for the site.

Additional photocopies should be taken for contractors.

Responsibilities of the authorised person (MGPS) for the permit-to-work procedure

6.41 The responsibilities of the authorised person (MGPS) are as follows:

- a. obtaining permission for interruption of supplies and affixing "do not use" or other prohibition notices;
- b. preparing permit;
- c. supervising isolation of section on which work is to be carried out;
- d. explaining details of work to competent person (MGPS);
- e. supplying drawings of existing sections of the installation "as fitted";
- f. supervising performance, cross-connection and identity tests of completed work as appropriate;
- g. supervising purging with working gas;
- h. final testing, assisted by the QC in the case of high hazard work;
- j. final testing in the case of low and medium hazard work;
- k. restoring service;
- m. supervising or making final connection of any extension;
- n. notifying designated medical officer or designated nursing officer of completion of work and removal of "do not use" notices;
- p. obtaining corrected copy of drawings;
- q. supervising amendments of office copy of "as-fitted" drawings;
- r. retaining original copy of permit and all permit books;
- s. obtaining designated medical or nursing officers signature on Part 8 and return the system to service.

Responsibilities of the competent person (MGPS) for the permit-to-work procedure

6.42 The responsibilities of the competent person (MGPS) are as follows:

- a. signing Part 3 of the permit, acknowledging responsibility for the work;
- b. obtaining and understanding instructions on work to be done;
- c. isolating section of system on which work is to be carried out, under direct supervision of authorised person (MGPS);
- d. carrying out the work;
- e. carrying out system integrity tests on completed work under direct supervision of authorised person (MGPS);
- f. signing Part 4 on both the original permit (held by the authorised person (MGPS)) and the copy 1 declaring that the work is completed as indicated on the permit.

Responsibilities of the designated medical and nursing officers

6.43 The responsibilities of the designated medical and nursing officers are as follows:

- a. signing Part 1 of the permit to agree that the system can be taken out of use for servicing or maintenance;
- b. advising other clinical staff that the system is not available for use;
- c. on completion of the work, signing Part 8 of both the original and copy of the permit accepting the system back into use;
- d. advising clinical colleagues and departmental heads that the system is available for use.

Responsibilities of the quality controller (QC)

6.44 The QC is involved in testing after high hazard work only. The responsibilities of the QC are as follows:

- a. identify the test equipment required, depending upon the specific service which has been disrupted;
- b. carry out final identity and quality tests on the systems;
- c. sign Part 7 of the original permit (held by the authorised person (MGPS)) and copy 2 declaring that the testing is completed as indicated on the permit.

Preparation and issue of permit-to-work

6.45 The authorised person (MGPS) should prepare Part 2 of the permit. He/she should identify, from the MGPS drawings, the work to be done and the means of isolation, unless the work to be done is of a low hazard nature.

6.46 Except in the case of low hazard work, he/she should normally re-check the permit whilst looking at the actual installation to make sure that the possibility of unexpected cross-connections has been carefully considered. He/she should give a brief summary of the work and information on other relevant permits which are in force. If work is to be carried out only on terminal units which incorporate integral isolating valves, he/she should enter

6.0 Operational procedures

in the "isolation" space on the permit: "terminal units have integral isolating valves". The authorised person (MGPS) should affix "do not use" or other prohibition notices to terminal units and plant as appropriate.

6.47 Wherever possible drawing reference numbers should be identified on the permit. A copy of the relevant drawing should be attached to the permit.

6.48 The competent person (MGPS) should read the permit, question anything that he/she does not understand and then sign Part 3, to certify that he/she has read and understood it.

6.49 Copy 1 should then be placed in a protective cover and given to the competent person (MGPS). The original and copy 2 should remain in the book.

6.50 The authorised person (MGPS) should ensure that the competent person (MGPS) is aware of the need for fire and other safety precautions, particularly if any brazing is to be carried out, and that permits-to-work which may be required for safety reasons, for example work in confined spaces, have been issued.

Action on completion of work

6.51 The competent person (MGPS) should sign Part 4 of the original permit, to certify that work has been completed, and call the authorised person (MGPS) to examine and test the installation. The competent person (MGPS) should also sign Part 4 of copy 1 of the permit for his/her records.

6.52 The authorised person (MGPS) should satisfy himself/herself that the work has been satisfactorily completed and should supervise the testing of valve tightness, pressure, cross-connection, flow rate and delivery pressure, and of the alarm system, in accordance with the recommendations of 'Design considerations'.

6.53 On satisfactory completion of all tests, the authorised person (MGPS) should supervise the reconnection of the isolated system to the main system and purge with the working gas.

6.54 The authorised person (MGPS) should then complete Part 5 of the permit on the original permit.

6.55 In the case of low and medium hazard work, the authorised person (MGPS) should complete Part 6 of the permit, when satisfied that the system may be taken into use.

6.56 For high hazard work, the authorised person (MGPS) and the QC should complete Part 7 of the permit, when satisfied that the MGPS may be taken into use.

6.57 In the case of high hazard work, the authorised persons (MGPS) should invite the QC to assist him/her in carrying out the identity and quality tests and accepting the MGPS for use.

6.58 Copy 2 should be given to the QC.

6.59 The authorised person (MGPS) should inform the designated medical or nursing officer that the work is completed and that the MGPS is now available for use, and the designated medical or nursing officer should sign Part 8, accepting the pipeline back into service.

6.60 The authorised person (MGPS) should remove any “do not use” or other prohibition notices. The authorised person (MGPS) should retain the book with the completed original permit.

Tests after work on the MGPS

General

6.61 The objective of testing is to ensure that all the necessary safety and performance requirements of the MGPS will be achieved. To verify this, four types of test are specified:

- a. cross-connection;
- b. performance;
- c. identity;
- d. quality.

6.62 The actual tests required depend on the level of hazard of the work which has been carried out.

6.63 Full details of the tests, test equipment, procedure and responsibilities are given in ‘Design considerations’. The test requirements are summarised below for completeness.

Cross-connection tests

6.64 Following any work which involves cutting or brazing, each system in turn, including vacuum, should be checked to ensure that there is no cross-connection between pipelines for different gases and vacuum.

6.65 Cross-connection tests must not commence until all installations are complete and all AVSUs must be open. The system under test must be at pipeline distribution pressure, and all other systems must be at atmosphere pressure.

In critical areas, it is recommended that there are at least two AVSUs serving each area. Where pendants are installed, these may be pneumatically controlled using medical air. In this case, both the terminal units in the pendant and the pneumatic function may be connected with three separate non-interchangeable screw thread (NIST) connectors, and supplied from two different AVSUs. Although it would not be possible to connect the wrong gas during the cross-connection tests, a check should be made to ensure that the correct AVSU is controlling the correct NISTs.

6.66 The test involves carrying out a check of all terminal units which may have been affected by the work, to ensure that gas flows from every terminal unit of the system under test, but that there is no gas flow from any other terminal unit.

Performance tests

6.67 Performance tests include tests at each terminal unit to ensure that the correct flow is delivered at the specified pressure and tests to demonstrate the correct operation of the warning and alarm systems.

Identity

6.68 The identity of the gas must be tested at every terminal unit which may have been affected by the work, and the composition of all compressed gases must be positively identified.

6.0 Operational procedures

6.69 An oxygen analyser is used for O₂ and O₂/N₂O mixture and medical and surgical air. A nitrous oxide analyser is used for N₂O. The requirements are given in 'Design considerations'.

Quality

6.70 The quality of the gas must be tested at every terminal unit which may have been affected by the work. The objective of the tests is to establish whether the pipeline has been contaminated during the work.

Monitoring and test equipment

6.71 All monitoring and test equipment used for MGPS should be purchased to the appropriate quality standard and instrumentation should be calibrated in accordance with NAMAS Standards.

Procedure for cleaning contaminated vacuum systems

General

6.72 The use of vacuum controlled units with overflow protection devices is essential to avoid contaminating the system with aspirated bodily fluids.

6.73 On rare occasions contamination can occur if, for example, a float valve has been poorly maintained and fails. In such an event it is essential to act promptly to clean the system before the fluids dry out and clog the system.

6.74 The procedure will involve aspirating a cleaning solution of detergent from the contaminated terminal unit and several other terminal units to clean the system.

Cleaning procedure

6.75 The following course of action is recommended:

- a. the authorised person (MGPS) should be advised immediately of the incident so that downstream terminal units, if possible, can be taken out of service under the permit-to-work procedure;
- b. establish, in consultation with the surgical or clinical practitioners, the possible volume of contaminant and its substance;
- c. consult the infection control officer to ascertain the level of microbiological hazard, including the pathogenicity and persistence of any infectious agents;
- d. from a study of the "as-fitted" drawings, identify any downstream and upstream terminal units likely to become flooded during the cleaning process;
- e. prepare about 10 litres of hot water with 1% Teepol or similar, for example Savlon;
- f. aspirate about 1 litre of the solution in a terminal unit immediately upstream. Insert a vacuum control unit and adjust to a small flow;
- g. aspirate about half the solution through the contaminated terminal unit and insert a vacuum control unit and adjust as in (f);

- h. aspirate about ½ litre of solution through the next ten or so downstream terminal units and connect a vacuum control unit to each and adjust as in (f);
- j. check other downstream terminal units for presence of solution. Where such evidence is found, repeat (h);
- k. repeat (f) to (j) using clean hot water.

Note: at this stage the system can be taken back into clinical use;

- m. leave the system running and check the plant for evidence of fluid in the filter sight glasses;
- n. where fluid is present, change the bacterial filters in accordance with paragraphs 10.113–10.116;
- p. monitor the system over the next few days, with the vacuum control units connected, for presence of liquid in the system. (The system will eventually dry out as the liquid vapour pressure equilibrates to the vacuum in the pipeline, but this may take several days.)

7.0 Training and communications

Training

- 7.1** It is essential that personnel at all levels have a sound general knowledge of the principles, design and functions of MGPS. They should be trained on those specific systems for which they will be responsible.
- 7.2** A training programme should be established for all staff responsible for MGPS. All training should be recorded and reviewed regularly.
- 7.3** All authorised and competent persons (MGPS) should have satisfactorily completed an appropriate training course before they are appointed. Suitable courses are run by specialist consultants and by specialist companies.
- 7.4** Satisfactory completion of an appropriate training course is not in itself sufficient for appointment as an authorised or competent person (MGPS). All staff should have sufficient experience and be familiar with their particular installations before they can be appointed as authorised or competent persons (MGPS).
- 7.5** All authorised persons (MGPS) should be re-assessed every three years and should have attended a refresher or other training course prior to such re-assessment. The recommendation for appointment or re-appointment as an authorised person (MGPS) should be made by a chartered engineer who has specialist knowledge of MGPS.
- 7.6** The QC should also receive specific training covering the responsibilities and duties which he/she will be required to carry out. It may be appropriate for the QC to attend part or all of the training courses for authorised persons (MGPS).
- 7.7** The medical and nursing staff who use the MGPS should be trained in the use of the system. This training should include the practical use of the system, emergency and safety procedures. **This is particularly relevant to the designated medical and nursing officers, who may need to receive more detailed training in specific areas such as emergency procedures.** The executive manager should ensure that all staff have received this training prior to using the MGPS and that refresher courses are arranged at least annually.

Communications

- 7.8** All staff who are involved in the use, installation or maintenance of MGPS should be aware of the operational policy and their specific responsibilities.
- 7.9** The operational policy should set out the means of communications between the various key personnel. It should, for example, define those departments which need to be informed of work on the MGPS, the personnel to be notified and whether such information is to be verbal or in writing.
- 7.10** The action to be taken in the event of a fault should be set out with a clear means of reporting the fault to the estates management.

8.0 Cylinder management

Cylinder storage and handling

General

- 8.1** This section is concerned with the operational aspects of medical gas cylinders, including storage, handling and general safety, and applies also to the storage and handling of pathology and industrial cylinders.
- 8.2** This operational guidance incorporates the guidance given in HEI 163 and WKO (85) 1.
- 8.3** This guidance represents the minimum standard applicable to all new installations. The general principles should be followed on existing installations so far as is reasonably practicable.
- 8.4** Existing storage facilities should have been designed to comply with the recommendations of HTM 16, HTM 2022 or earlier editions of HTM 22 as appropriate. Gas cylinders should have been stored in either a store room which is part of the health building or a separate, specially-constructed building, both areas being used exclusively for medical gas cylinders. These stores will usually be satisfactory, provided that the ventilation is adequate.
- 8.5** Cyclopropane is no longer available as a medical gas.
- 8.6** The decanting and filling of medical gas cylinders is subject to the Pressure Systems and Transportable Gas Containers Regulations 1989 and the Health and Safety at Work etc Act 1974. Unless the healthcare organisation has a relevant manufacturer's licence and product licence, and can demonstrate compliance with the Pressure Systems and Transportable Gas Containers Regulations 1989, these activities should not be carried out under any circumstances. Decanting is not recommended, but if absolutely unavoidable, and the above criteria can be met, the advice of the gas supplier should be sought and implemented.

Classification of gas cylinders

- 8.7** In this document, gas cylinders are classified into two main categories – medical and non-medical. **Cylinders from these two categories must never be mixed, either in storage or in use.**
- 8.8** Gas cylinders are subdivided into groups, depending on the major risk associated with the cylinder contents as follows:
- a. Group 1 – flammable;
 - b. Group 2 – oxidising;
 - c. Group 3 – toxic or corrosive (the contents may also be flammable or oxidising);
 - d. Group 4 – others (including inert gases).

8.0 Cylinder management

The most common gases, grouped as above, likely to be used in health buildings are shown in the table below.

Table 1 Classification of gas cylinders

Group classification of gas cylinder contents	Medical gases	Non-medical gases
1 Flammable (Red diamond on label)		acetylene; LPG (eg propane, butane); STG (synthetic town gas) methane, natural gas; hydrogen
2 Oxidising and/or supports combustion (Yellow diamond on label)	oxygen; nitrous oxide oxygen/nitrous oxide oxygen/carbon dioxide oxygen/helium mixtures	oxygen nitrous oxide oxygen/nitrous oxide mixtures
3 Toxic and corrosive		
3.1 Toxic and/or corrosive and flammable		ammonia; ethylene oxide (C ₂ H ₄ O); carbon monoxide; C ₂ H ₄ O/CO ₂ mixtures; >6% C ₂ H ₄ O
3.2 Toxic and/or corrosive and oxidising		nitric oxide mixtures; sulphur dioxide; chlorine
3.3 Toxic and/or corrosive only		ethylene oxide/halo-carbon mixtures <15% C ₂ H ₄ O); certain conditions only ethylene oxide/carbon dioxide mixtures <6% C ₂ H ₄ O
4 Others including inert, but excluding toxic or corrosive (Green diamond on label)	carbon dioxide; helium; medical air; nitric oxide; 1000 vpm in nitrogen	compressed air; carbon dioxide; nitrogen; argon; helium; halo-carbon; refrigerants

Safety – main principles

8.9 The main hazards associated with gas cylinders are:

- a. careless storage, handling, dropping or impact can cause physical or personal injury. These hazards should be minimised:
 - (i) by the correct design, siting and construction of cylinder storage areas,
 - (ii) by the provision of suitable storage and handling equipment; and
 - (iii) by the adoption of safe operating practices;
- b. leakage of gas where the cylinder contents may be flammable, oxidising, asphyxiant, anaesthetic, toxic or a combination of these characteristics. In the event of leakage, gas may collect in a confined space and cause or contribute to a fire, explosion or health hazard.

Accommodation for medical gas cylinders

General

- 8.10** Accommodation for medical gas cylinders (main stores and ready-to-use stores) should comply with the following design guidelines:
- a. **ventilation** – all cylinder stores should be well ventilated;
 - b. **labelling** – all cylinder stores should be clearly labelled as appropriate with the type of cylinders contained;
 - c. **emergency action** – details of emergency action procedures and location of keys together with “no smoking” and other warning signs should be clearly posted on the front of the cylinder store;
 - d. **access** – clear and secure access to all cylinder stores is required, including adequate space for vehicular access and cylinder loading/unloading;
 - e. **fire protection** – all cylinder stores should be free from naked flames and all sources of ignition, and should be designated “no smoking” areas. Appropriate fire extinguishing equipment should be readily available;
 - f. cylinder stores for medical gases should only contain medical gas cylinders;
 - g. industrial and pathology gases cylinders should be stored in a separate, appropriately designated store.

Design and construction of cylinder stores

General

- 8.11** Cylinder stores should be covered and adequately ventilated. Stores should not be located in close proximity to any installation which may present a fire risk or other hazard.
- 8.12** The floor and hard standing should be level and constructed of concrete or other non-combustible, non-porous material. A concrete finish is preferred and is likely to have a longer life. The floor should be laid to a fall to prevent the accumulation of water.
- 8.13** The store should have easy access for trolleys. The cylinder bays should be arranged to allow trolleys to be safely manoeuvred and cylinders to be loaded and unloaded.
- 8.14** Separate, clearly identified bays should be provided for full and empty cylinders.
- 8.15** Separate areas for different gases should be provided, but it is not necessary to construct a physical barrier unless it is convenient to do so. Adequate means of securing large cylinders should be provided to prevent falling. Small cylinders should be secured in racks in accordance with BS 1319.
- 8.16** The doors should be large enough to facilitate cylinder loading/unloading and should be on an external wall. The emergency exit should be provided with a panic-release lock. Doors should open outwards.

8.0 Cylinder management

8.17 If the travel distance from the access doors to any part of the stores exceeds 15 m, additional emergency exits should be provided. The advice of the local fire safety officer should be sought.

Hazchem/warning signs

8.18 Safety warning signs and notices should be used where appropriate and posted in prominent positions. They should be sited and designed in accordance with the requirements of SI 1980 No 1471 'The Safety Signs Regulations 1980'; BS 5378: Part 1: 1980, Part 3: 1982 'Safety Signs and Colours'; BS 5499: Part 1: 1984 'Fire Safety Signs Notices and Graphic Symbols' and the Health and Safety at Work etc Act 1974.

Location

8.19 Cylinder stores should be located at ground level, not underground, for example in a basement.

8.20 Cylinder stores should be located as close as possible to the delivery point. Wherever possible there should be only one delivery supply point for each site.

8.21 No parking should be permitted within the delivery and storage area, other than for loading and unloading cylinders.

8.22 The location of the cylinder store should be marked clearly on the site plan for ease of identification in the event of an emergency.

Handling of cylinders

General

8.23 Cylinders can be heavy and bulky and should therefore be handled with care only by personnel who have been trained in cylinder handling and who understand the potential hazards.

8.24 A suitable trolley should be used for transporting cylinders whenever they are moved.

8.25 Cylinders should not be lifted by their guards or valves unless specifically designed for that purpose.

8.26 Cylinders should not be dropped, knocked, used as "rollers" or be permitted to strike each other violently.

8.27 Cylinders and valves should be kept free from oil, grease and other debris. Cylinders should not be marked with chalk, crayon, paint or other materials, nor by the application of adhesive tapes etc. A tie-on label indicating the content state may be attached to the cylinder.

8.28 Smoking and naked lights should be prohibited in the vicinity of all cylinders.

8.29 Cylinders should always be secured during transportation and in use.

8.30 Safety devices, including pressure relief devices, valves and connectors should not be altered or by-passed.

8.31 Repairs, alterations or modifications should not be undertaken on any part of an MGPS, including pressure reducing regulators, except by appropriately trained personnel with adequate service facilities including maintenance manuals and recommended spares.

8.32 Markings used for identification of cylinder contents, pressure testing of cylinders, tare weights, etc, should not be defaced or removed. This also applies specifically to cylinder product labels.

8.33 Cylinders should not be painted or otherwise obscured in a manner which would prevent identification of their contents, and care should be taken to preserve their labels and surface finish.

8.34 Cylinders used for industrial purposes should not be used for medicinal applications and should not be stored in the same store as medical gases cylinders. Similarly, medical gases should not be used for non-medical applications.

8.35 Cylinder valves should not be dismantled or tampered with.

8.36 Cylinder valves should always be closed after use and when cylinders are empty. Keys for this purpose should be readily available. Any gas trapped within the regulator/equipment should be safely vented to atmosphere and the equipment valves re-closed.

Protective clothing

8.37 Heavy protective gloves (preferably textile or leather) and protective safety footwear should be worn when loading or unloading cylinders, to minimise the risk of injury. Gloves, protective boots and overalls should be clean and free from oil and grease. Additional precautions are required for handling cryogenic gases, see paragraphs 9.17 to 19.19.

Unloading equipment

8.38 The joist or tail-loader used with the delivery vehicle should be as clean as is practicable and mechanical parts shielded to prevent contamination of cylinders with oil and grease.

Trolleys, trucks and vehicles

8.39 The following should be noted:

- a. cylinder trolleys should conform to BS 2718. Where different types of conveyance are used to transport several cylinders together, they should be clean, the cylinder supporting surfaces should be free from grease and oil and they should be reserved for the transportation of gas cylinders;
- b. precautions should be taken to prevent cylinders falling from trolleys, trucks or vehicles.

8.40 Vehicles transporting gas cylinders and using public roads should, where applicable, be appropriately marked in accordance with the proposed

requirements of the Health and Safety Executive's 'Packaging of dangerous substances for conveyance by road'.

Transportation of cylinders with equipment attached

8.41 In some circumstances it may be necessary to transport cylinders with equipment attached. Unless it is essential for a patient to continue receiving a supply of gas, the cylinder valve should be closed and any gas contained in the equipment or regulator should be safely vented to atmosphere before transporting the cylinder.

Preparation of cylinders for use

8.42 The following preparations should be made before use:

- a. check the cylinder label to ensure the correct gas has been supplied;
- b. the tamper-evident seal should be removed and any plastic outlet cap removed and left attached to the valve for re-fitting after use;
- c. cylinders should only be used in conjunction with equipment designed for their use;
- d. cylinder identification labels should not be removed or obscured. No permanent marking or painting should be made to the cylinder shell, except by the manufacturer/supplier;
- e. lubricants, sealing or joining compounds should not be used when connecting cylinders to pressure reducing regulators. The cylinder valve, regulator and associated equipment should always be clean and free from oil, grease and other debris;
- f. cylinder and equipment connection interfaces and their washers or "O" ring seals should be inspected to make sure that they are in good condition. Damaged sealing washers and "O" rings should be replaced. Not more than one sealing washer should be used at each interface;
- g. portable nitrous oxide/oxygen cylinders should ideally be stored at above 10°C prior to use; where the temperature falls below 0°C it is possible for the constituent gases to separate. If cylinders are stored at temperatures lower than 0°C for long periods prior to use, they should either be inverted at least three times or stored at above 10°C for 24 hours prior to use to ensure the correct gas specification. Under no circumstances should cylinders be immersed in water prior to use;
- h. in the case of large (G-size) nitrous oxide/oxygen mixture cylinders, they should be stored upright within the manifold room at a minimum temperature of 10°C for a period of 24 hours before connection to the manifold.

Connecting cylinders to equipment or manifolds

8.43 The following procedures should be implemented:

- a. connect the cylinder to the equipment or manifold tail pipe and tighten firmly with the recommended key or by hand as appropriate. Excessive force should not be used;
- b. ensure that no leaks are present at the junction between the cylinder valve and equipment and also between the valve spindle and gland nut. This may generally be determined by sound. If in doubt, use a

A 1% solution of Teepol should be used for leak testing on cylinder connections

For two-stage regulators, the outlet pressure valve should be fully turned in an anti-clockwise direction

proprietary leak detection fluid. If a proprietary fluid is used, it should be wiped off with a clean damp cloth after use. When tightening connections to stop gas leaks, excessive force should not be used. Sealing or jointing compounds should never be used;

- c. the connection between the cylinder valve and equipment should be checked for leaks using an approved leak detector. When tightening the connection to stop gas leaks, excessive force should not be used;
- d. prior to opening the cylinder valve, ensure the equipment flow control valves are closed;
- e. using a recommended cylinder spindle key, or handwheel where fitted, the cylinder valve should be opened slowly to its fullest extent by turning the valve spindle anti-clockwise. The spindle is then turned back by approximately a quarter turn. A faulty key or excessive force should not be used, as these may damage the valve spindle;
- f. regulators or equipment should only be used with the gas for which they are designed;
- g. prior to opening the cylinder valve, ensure that the equipment flow control valves are closed;
- h. when the cylinder is not being used, the cylinder valve should be closed and the gas trapped within the regulator/equipment should be safely vented to atmosphere by opening the flow control valve and then closing it again.

Cylinder preparation for return to store

8.44 After use:

- a. the cylinder valve should be closed, any gas contained in the equipment and regulator should be safely vented to atmosphere and the equipment/regulator flow control valve closed. If the cylinder is to be removed or replaced, the recommended key should be used to disconnect the regulator or equipment;
- b. empty cylinders or those no longer required for use should be returned to store as soon as possible and appropriately identified as "empty". Protective outlet caps, where supplied, should be replaced.

Equipment for use with medical gas cylinders

Gas supply cylinder fittings

8.45 The inlet fittings on regulators and equipment used for connection to medical gas cylinders should be in accordance with the BS 341 and BS 1319.

Administration equipment

8.46 The following procedure should be implemented:

- a. lung ventilators, oxygen therapy apparatus and other equipment for use with cylinders should be so designed as to render the entire assembly stable during storage, transportation and use. If castors are used, they should conform to BS 2099;
- b. mobile equipment should be suitably buffered to reduce damage to the fabric of the healthcare buildings (see BS 4322);
- c. where a pressure relief valve is fitted to protect downstream systems, it should be indelibly marked with its relief pressure value. Regulators should be indelibly marked with the maximum outlet pressure range. Pressure gauges should be in accordance with BS 1780;
- d. needle valves or similar devices should **not** be used in place of pressure-reducing regulators, as excessive pressure may develop downstream of such devices and result in possible injury to personnel and damage to equipment.

Precautions against leakage of gas

8.47 A naked flame or lighted cigarette should not be used to detect leaks. Only proprietary leak detection fluids should be used and should be wiped off with a clean damp cloth after use to avoid possible contamination of the fittings.

8.48 If a leak is identified:

- a. between the cylinder valve and equipment:
 - (i) carefully tighten the connecting nut. Close the cylinder valve and vent any gas trapped within the equipment and open the cylinder valve slowly. If the leak persists, turn off the cylinder valve, vent any gas safely to atmosphere and detach the cylinder from the equipment;
 - (ii) where the connection incorporates a seal (either "O" ring or Bodok seal), this should be replaced and the cylinder reconnected to the equipment, following the procedure outlined in paragraph (a)(i). If a leak still persists the action taken above should be repeated;
 - (iii) Where the leak appears to be caused by the cylinder valve, notify the supplier of the faulty cylinder and retain for return under the "faulty cylinder" procedure;
- b. between the valve spindle and gland nut:
 - (i) tighten the gland nut in a clockwise direction using a recommended key and without using excessive force. This should be performed only by personnel trained in this procedure. This procedure is only relevant to pin index valves and any other cylinder with a gland nut leak should be returned to the supplier.

8.49 If the leak persists, close the cylinder valve, vent the gas safely to atmosphere, detach the cylinder from the equipment and return it under complaint procedure, to the supplier.

8.50 Excessive force should not be used when connecting cylinders or closing valves, as this may damage threads and valve seats. The need for excessive force may indicate a faulty valve seat and it should be reported to the supplier. The cylinder should be removed from use and identified as faulty by tying a label to the cylinder.

8.51 Sealing or joining compound should not be used to rectify leaks. Any leakage which cannot be rectified should be notified to the manufacturer and/or electro-biomedical equipment (EBME) department as appropriate in accordance with the operational policy.

8.52 Cylinders with damaged or very stiff valves should be labelled appropriately and returned to the supplier.

8.53 Defective pressure-reducing regulators, gauges and equipment may be hazardous in use. A system should be set out in the operational policy to ensure that defective items are withdrawn from use, and repaired or replaced as necessary.

8.54 No attempt should be made to repair, alter or modify any cylinder or its valve other than that advised in paragraph 8.48 (b)(i).

Equipment should be subject to planned preventative maintenance, see Chapter 10, "Maintenance"

Defective equipment should be notified to the appropriate body in accordance with the defect reporting system.

Precautions against fire, heat and chemicals

8.55 General fire precautions applicable to MGPS are given in the "Fire precautions" section of Chapter 9 "General safety and fire precautions".

8.56 Oil and grease in the presence of high-pressure oxygen and nitrous oxide are liable to combustion and should not be used as a lubricant on any gas cylinder or equipment. In particular, the cylinder valve, couplings, regulators, tools, hands and clothing should be kept free from these substances.

8.57 A hazardous situation could arise if cylinders are subjected to extremes of temperature. Cylinders should be kept away from sources of heat, including steam pipes and hot sunny positions.

8.58 When equipment is coupled to a cylinder, the cylinder valve should initially be opened as slowly as possible, as rapid opening can cause a sudden adiabatic increase in downstream gas pressure. The consequent temperature rise may result in ignition of combustible material in contact with the hot gas downstream. Only regulators designed for oxygen use should be used for this service as they are constructed to prevent this occurrence.

8.59 Serious incidents have occurred as a result of ignition occurring within the cylinder valve or regulator. This has been attributable to friction generated by particulate matter, such as dust or dirt, within the system when the cylinder valve is opened.

8.60 Cylinders and their associated equipment should be protected from contact with oil, grease, bituminous products, acids and other corrosive substances.

Cylinders involved in incidents

8.61 Compressed medical gas in cylinders may introduce fire, chemical, electrical and mechanical hazards. No attempt should be made to examine or use a cylinder and/or tamper with its valve after it has been involved in an incident, until the Department of Health and suppliers have been consulted. The procedure outlined in HN(83)21 should be followed.

In Scotland, SHHD Circular 1982 (GEN) 31 and 32 apply.

Storage of cylinders in manifold rooms

8.62 The number of cylinders in manifold rooms should be restricted to the minimum required for operational and reserve purposes. This will include cylinders connected to the manifold(s) and a sufficient reserve to replenish one complete bank. In the case of manifolds for nitrous oxide/oxygen mixtures, sufficient cylinders to replace two complete banks should be stored.

8.63 Only cylinders of the gases required for connection to the manifold should be kept in the manifold room. The manifold room should not be used for any other purpose, although an exception may be made for essential storage of nitrous oxide/oxygen mixture cylinders on trolleys to permit temperature equilibration before use with directly connected equipment.

Storage of cylinders in ready-to-use stores

8.64 In some areas it will be essential to hold small numbers of spare cylinders for immediate use for connection to anaesthetic machines and for sudden unanticipated demands. Such areas would include operating departments, A&E departments, coronary care units, central delivery suites of maternity departments, special care baby units, intensive therapy units, sterilizing and disinfecting units etc. These stores should only be used for full cylinders and all empty cylinders should be returned immediately to the main cylinder store.

8.65 The numbers of cylinders held should be kept to the minimum; a 24-hour supply should suffice for normal circumstances, although this may have to be increased for weekends, bank holidays etc and other operational reasons.

8.66 These cylinders should be kept in a specially designated room. This should comply as far as possible with the requirements for manifold rooms, but in any case should be well ventilated and where practicable have at least one external wall to facilitate natural ventilation.

8.67 This designated room should be clearly labelled with the types of cylinder contained and "no smoking" warning signs.

8.68 No combustible material should be kept in the ready-to-use store. The general principles given in paragraphs 8.83–8.85 and 6.61 should be followed where appropriate.

8.69 Cylinders should be stored in racks in accordance with BS 1319. Sufficient space should be provided for manoeuvring cylinders onto and off trolleys. Adequate means of securing large cylinders should be provided to prevent falling.

Cylinders placed in or returned to the ready-to-use store should be checked for leakage, to ensure that the cylinder valve is turned off. An adequate number of keys should be available.

8.70 Small cylinders of oxygen/nitrous oxide mixtures should be kept horizontal and placed away from ventilation openings where practicable.

Stock control and receipt of cylinders into stock

8.71 The objective of stock control and accounting is to ensure that the correct cylinders are received and used and that unnecessarily large stock holdings are avoided. It is also important to avoid excessive stock holdings of empty cylinders for which rental charges continue to apply. This may be achieved by using the gas supplier's proprietary stock management system which utilises the bar code information on cylinders to assist in efficient stock management control.

Ordering from suppliers

8.72 The written procedure detailing the method of ordering cylinders from commercial suppliers should be available in the appropriate departments. All orders should clearly specify that the gas is for medical purposes. It should also specify the gas required, the cylinder size and indicate that the cylinders and valves should comply with BS 341, BS 1319 and BS 5045. Ordering and stock-control records should be maintained to suit local requirements. These records should include the name of the gas, date of receipt, expiry date, cylinder size, batch number of each cylinder and quantity of cylinders received. Automatic replenishment systems may be used in conjunction with the gas supplier, provided that an agreed procedure is specified.

Returns to suppliers

8.73 The written procedure should detail the method of accounting for and returning of cylinders to the suppliers. Empty cylinders should not be retained longer than necessary in the main store, but returned at the earliest opportunity to the supplier to avoid unnecessary rental charges. This may also be covered by the automatic replenishment system described above.

Issue from stores

8.74 The following procedures should be implemented:

- a. the written procedure should detail the system by which cylinders are requisitioned for use;
- b. a record of issues should be kept. The record should include the name of gas, size of cylinder, date of issue, expiry date, number of cylinders issued and the department, ward or name of recipient. This may be covered by the proprietary stock management system.

Return of cylinders to stores

8.75 The written procedure should also be used for the return of empty or unused cylinders to the main store and for return to the supplier.

Receipt of cylinders into stock

8.76 Cylinders which do not conform to the following requirements will not be accepted:

- a. each cylinder should have:
 - (i) a product identity label;
 - (ii) a batch label;
- b. cylinders should be clean and free from rust, scale and the paint-work should be in a condition enabling easy identification from the colour code chart (BS 1319C);
- c. there should be a tamper-evident seal over the valve outlet.

8.77 The following procedures for the rotation of stock should be implemented:

- a. a written procedure should be prepared giving details of a rotational stock-control system;
- b. the main store should be large enough to permit the use of a rotational stock-control system. Racks for small cylinders should be designed to assist rotation of stock;
- c. where a system incorporating an in-use bay and a latest-delivery bay is used, the in-use bay should be emptied before a fresh delivery is loaded into it. Appropriate movable signs should be available.

Labelling/markings of cylinders

8.78 Cylinders should be colour-coded and marked in accordance with BS 1319 and the Classification of Packaging and Labelling of Dangerous Substances Regulations, SI 1244 1994 and 92/27 EC.

8.79 Each cylinder should have:

- a. a batch label to include a unique batch number, filling branch code, cylinder code and product, filling date and expiry date;
- b. product identification label which includes:
 - (i) the product licence number;
 - (ii) the name and chemical symbol of the gas or gas mixture contained in the cylinder. Additionally, in the case of gas mixtures, the proportion of constituent gases should be shown;
 - (iii) a hazard warning sign;
 - (iv) a substance identification number;
 - (v) specific product and cylinder handling precautions;
 - (vi) particular instructions to the user where necessary;
 - (vii) safety information;
- c. a serial number;
- d. test mark, year and quarter of test.

8.80 Cylinders, pressure-reducing regulators and pressure gauges should be conspicuously marked "**use no oil or grease**" or with the appropriate symbol.

8.81 Cylinder yokes, pressure-reducing regulators and pressure gauges should be clearly and indelibly marked with the designation of the gas or gas mixture for which they are intended. BS 1319 may be used as guidance.

8.82 Pressure gauges should be in accordance with BS 1780 or with the appropriate standard for the particular type of medical equipment or to BS 4272: Part 3: 1989, as appropriate.

Restriction on use of storage accommodation

8.83 The main stocks of oxygen, nitrous oxide, medical compressed air and other medical gas cylinders should be stored in the designated cylinder store. No other materials should be kept in the store.

8.84 Cylinders should be stored in racks to BS 1319 and used in rotation as received. As cylinders are emptied and taken out of use, heavy duty tie-on labels clearly marked “**empty**” should be attached to empty cylinders. Empty cylinders should be stored separately from the full cylinders.

8.85 Manifold rooms may be used for limited storage of cylinders only to the extent indicated within this document.

Notices

8.86 Smoking, welding and naked lights are prohibited within or near the manifold room, plantroom and liquid oxygen compound area and the cylinder store. This prohibition also applies to the vicinity of the outlet of the discharge pipe from medical gas safety valves. Safety signs should be provided within and outside these areas to indicate this requirement, for example “**smoking, welding and naked lights prohibited – medical gas storage area**”. In addition, a notice clearly indicating the contents of these areas should be displayed.

8.87 Safety signs should be provided in accordance with the ‘Safety Signs Regulations 1980’ and are available from the gas supplier. Further guidance is also given in HTM 65 supplement for fire safety signs.

8.88 Notices should be posted in wards and departments informing staff of the location of those medical gas control valves which should be turned off in the event of a major fire in the ward or department.

Access to manifold rooms and liquid oxygen storage areas

8.89 Access to the manifold room and liquid oxygen storage area should be controlled. A duplicate key of each should be kept in a locked box with a transparent front cover at the main fire entrance, gatehouse or equivalent building so that in the event of a fire a member of the fire brigade may obtain a key immediately he/she enters the hospital site. The transparent front of the box should be labelled:

BREAK COVER TO OBTAIN KEY FOR EMERGENCY USE ONLY

Where this would not be desirable for security reasons, a prominent notice clearly stating the location of the key should be displayed.

Fire detection system

8.90 Smoke/heat detectors should be installed in the plantrooms, medical gases manifold rooms and in ready-to-use medical gas cylinder stores in hospitals with an automatic fire detection system, in accordance with 'Firecode'.

Classification of hazardous areas for the selection of electrical equipment based on BS 5345: Part 1: 1976

8.91 By implication, an area that is not classified Zone 0, 1 or 2 is deemed to be a non-hazardous or safe area with respect to the code of practice. The code of practice is based on the concept of dealing with the risk of fire and explosion by area classification.

8.92 This concept recognises the differing degrees of probability with which concentrations of explosive (flammable) gas or vapour may arise in installations, in terms of both the frequency of the occurrence and the probability, that is, duration of existence on each occasion.

8.93 The definitions appropriate are as follows:

- a. Zone 0 – in which an explosive gas-air mixture is continuously present, or present for long periods;
- b. Zone 1 – in which an explosive gas-air mixture is likely to occur in normal operation;
- c. Zone 2 – in which an explosive gas-air mixture is not likely to occur in normal operation and if occurring will only exist for a short time.

Reference should be made to BS 5345 before specifying or installing electrical equipment for cylinder storage areas.

9.0 General safety and fire precautions

General safety

General

9.1 The safety of MGPS is dependent on four basic tenets:

- a. identity;
- b. adequacy;
- c. continuity;
- d. quality of supply.

9.2 Identity is assured by the use of non-detachable gas-specific connections throughout the pipeline system, including terminal units, connectors, etc, and by the adherence to strict testing and commissioning procedures of the system. Industrial shradder outlets do not comply with BS 5682 and should **not** be used.

9.3 Adequacy of supply depends on an accurate assessment of demands and the selection of plant with capacity appropriate to the clinical/medical demands on the system.

9.4 Continuity of supply is achieved by the specification of a system which, with the exception of liquid oxygen and separated synthetic air systems, have duplicate components and by the provision of an adequate emergency/reserve supply for all systems, except vacuum, by the provision of alarm systems and by connection to the emergency power supply system. Anaesthetic gas scavenging systems (AGSS) and high-pressure surgical air systems are not considered as life-support systems and therefore duplicate components and an emergency/reserve supply system is not necessarily required. Adequate provision should, however, be made for continuity in the event of a failure of the supply.

9.5 Quality of supply is achieved by the use of gases purchased to the appropriate European Pharmacopoeia (Ph Eur) requirements or produced by plant performing to specified standards, by the maintenance of cleanliness throughout the installation of the system and by the implementation of various testing and commissioning procedures.

Modifications

9.6 Special precautions are required when existing installations are to be modified or extended, to ensure that any section of the pipeline system remaining in use is not contaminated or the supply to patients compromised. The section to be modified should be physically isolated from the section in use. Closure of isolating valves is insufficient for this purpose. Where area valve service units (AVSUs) have been installed, the blanking spades should be used. This isolation procedure is not required when work is to be carried out on individual terminal units, providing that no brazing is required.

9.7 Modification of existing systems may be detrimental to the overall performance of the system. In the case of older systems there may be insufficient capacity to permit the system to operate safely with the flows typically encountered in use today.

9.8 Any work involving alteration, modification, extension or maintenance work on an existing system should be subject to the permit-to-work procedure – see the “Permit-to-work” section of Chapter 6 “Operational procedures”.

Safety statement for users of oxygen equipment

9.9 The characteristics of oxygen are:

- a. in the liquid state oxygen is pale blue, with a boiling point of -183°C at atmospheric pressure;
- b. in the gaseous state oxygen is colourless, odourless, tasteless, non-toxic, non-irritant and non-flammable. It will, however, strongly support combustion, and is highly dangerous when in contact with oils, greases, tarry substances and many plastics.

9.10 When oxygen therapy equipment is in use, fire and safety warning signs/labels should be conspicuously displayed at the site of administration to alert the patient, healthcare personnel and visitors that oxygen is being used and of the need to take appropriate precautions. It is recommended that the text is accompanied by a warning sign.

9.11 When oxygen is being administered in paediatric departments, the text should include the precaution: “**Only toys approved by the hospital fire officer may be given to the child.**”

9.12 Oxygen canopies, hyperbaric chambers and tents should be labelled, advising that oxygen is in use and that safety precautions relating to its use should be observed. Labels should be attached to the fabric of the canopy/tent in a position easily seen by the patient and also on the exterior in a position to be seen easily by healthcare staff and visitors.

9.13 Considerations may need to be given for signs in other languages.

9.14 **All users of oxygen and associated equipment should know and understand the properties of oxygen and should be trained in the use of the equipment. This applies to all staff.**

The guidance given in ‘Firecode: Policy and principles’ should be followed.

9.15 The health hazards associated with liquid oxygen are:

- a. cold burns and frostbite. Localised pain usually gives a warning of freezing, but sometimes no pain is felt or it is short-lived. Frozen tissues are painless and appear waxy, with a pale yellowish colour. When the frozen tissue thaws it can result in intense pain with associated shock. Loosen any clothing that may restrict blood circulation and seek immediate hospital attention for all but the most superficial injuries. Do not apply direct heat to the affected parts, but if possible place the affected part in lukewarm water. Sterile, dry dressings should be used to protect damaged tissues from infection or further injury, but they should not be allowed to restrict the blood circulation. Alcohol and cigarettes should not be given;
- b. the effect of cold on lungs. Prolonged breathing of extremely cold atmospheres may damage the lung tissue;

- c. hypothermia. A risk of hypothermia arises when liquefied atmospheric gases are released. All persons at risk should be warmly clad. Hypothermia is possible in any environment below -10°C , but susceptibility depends on length of exposure, atmospheric temperature and, not least, the individual. Older people are more likely to be affected;
- d. the formation of mist. When liquefied atmospheric gases are released, a white mist is formed by the condensation of atmospheric moisture when liquefied gas is in contact with it. The mist formation may cause injuries as a result of tripping because of poor visibility. In the event of mist formation, extreme caution should be exercised when evacuating the area.

Material compatibility

9.16 Gaseous oxygen vigorously supports combustion of many materials which do not normally burn in air, and is highly dangerous when in contact with oils, greases, tarry substances and many plastics. Only materials approved for oxygen service may be used.

Protective clothing for handling cryogenic gases

9.17 Protective clothing is only intended to protect the wearer (handling cold equipment) from accidental contact with liquefied atmospheric gases or parts in contact with it. Non-absorbent leather gloves should always be worn when handling anything that is, or has recently been, in contact with liquefied atmospheric gases. The gloves should be loose-fitting so that they can be removed easily. Sleeves should cover the ends of gloves. Gauntlet gloves are not recommended because liquid can drip into them. Woven materials are best avoided, but if they are used for protective clothing it is essential to ensure they do not become saturated with cold liquid.

9.18 Goggles or a face mask should be used to protect the eyes and face where spraying or splashing of liquid may occur. Overalls, or similar type clothing, should be worn. These should preferably be made without open pockets or turn-ups where liquid could collect. Trousers should be worn outside boots for the same reason. If clothing becomes contaminated with liquefied atmospheric gases or vapour, the wearer should ventilate them for a minimum of 5 minutes, by walking around in a well-ventilated area, avoiding exposure to naked flames.

9.19 Safety note: for more detailed safety instructions on liquefied atmospheric gases, the advice of the supplier should be sought.

Other medical gases

9.20 Guidance available from the manufacturers should be followed.

Fire precautions

General

9.21 The general guidance on fire precautions given in 'Firecode' should be followed. Specific guidance on fire precautions relating to cylinders is given in Chapter 8 "Cylinder management".

9.22 Guidance is also available from the gas supplier and any specific recommendations should be followed.

9.23 Fire can occur when the following three conditions are present:

- a. flammable materials;
- b. oxidising atmosphere;
- c. ignition.

9.24 Flammable materials should not be present in cylinder stores, manifold rooms or liquid oxygen compounds. It may not, however, be possible to avoid the presence of flammable materials in the vicinity of the patient when medical gases are being used.

9.25 Flammable materials which may be found near patients include some nail varnish removers, oil-based lubricants, skin lotions, cosmetic tissues, clothing, bed linen, rubber and plastic articles, alcohols, acetone, certain disinfectants and skin-preparation solutions.

9.26 An oxygen-enriched atmosphere may be present when medical oxygen or nitrous oxide/oxygen mixtures are used. Nitrous oxide also supports combustion.

9.27 Staff should be aware of the contents of HTM 83 and HC(78)4, 'The Organisation and Maintenance of Fire Precautions in the National Health Service'.

In Scotland, NHS Circular No 1978(GEN)42 applies.

9.28 Further guidance should be obtained from the fire prevention officer, the fire safety officer and the local fire brigade.

9.29 Ignition sources are numerous and include:

- a. open flames, burning tobacco, sparks (which may also be produced by some children's toys); high frequency, short wave and laser equipment; hair dryers; arcing; and excessive temperatures in electrical equipment. The discharge of a cardiac defibrillator may also serve as a source of ignition;
- b. electrical equipment not specifically designed for use in an oxygen-enriched atmosphere;
- c. some non-electrical equipment. For example, a static discharge, which may be created by friction, may constitute an ignition source if easily ignited substances such as alcohols, acetone, some nail varnish removers, oils, greases or lotions etc are present.

9.30 A mixture of breathing gases will support combustion. In an oxygen or nitrous oxide-enriched atmosphere, materials not normally considered to be flammable may burn vigorously. Flammable materials ignite and burn more vigorously.

9.31 Clothing may become saturated with oxygen or nitrous oxide and become an increased fire risk. When returned to normal ambient air, clothing takes about five minutes for oxygen enrichment to reduce to normal conditions. Blankets and similar articles should be turned over several times in normal ambient air following suspected oxygen enrichment.

9.32 Oil and grease, even in minute quantities, are liable to ignite in the presence of high-pressure oxygen or nitrous oxide. No oil or grease should be used in any part of the MGPS. In particular, oil-based lubricants should not be used and all fittings, pipes etc should be supplied degreased, sealed and labelled for MGPS. Details of these requirements are given in 'Design considerations'.

9.33 The siting and general structural principles for the design of liquid oxygen storage accommodation are stated in Chapter 6 of 'Design considerations' and for plantrooms and gas manifold rooms in Chapter 14 of 'Design considerations'. Cylinder storage should be as recommended in Chapter 8 "Cylinder management".

Ventilation

9.34 Waste anaesthetic gas discharges are usually controlled by scavenging and/or ventilation to comply with the requirements of COSHH. Where oxygen is used for specific therapies, for example in oxygen tents or in continuous positive airway pressure (CPAP) ventilation regimes, oxygen enrichment may occur. It is essential, therefore, that adequate general ventilation should be provided to avoid the hazard.

10.0 Maintenance

General

10.1 MGPS should be subjected to planned preventative maintenance (PPM) and should be under the responsibility of the authorised person (MGPS), irrespective of whether or not a full preventive maintenance scheme is being implemented in the hospital as a whole.

10.2 All work should be carried out in accordance with HTM 2022 and/or C11 as applicable and as modified from time to time.

10.3 All work on an MGPS, whether or not the supply is or is likely to be interrupted, should only be carried out under the instructions of, and with the prior permission of, the authorised person (MGPS).

10.4 Since the authorised person (MGPS) is responsible for the operation of the MGPS, his/her decision should be final in all cases.

10.5 The operational policy should clearly set out the responsibilities and the procedures to be followed for all work on the MGPS.

10.6 No work should be carried out on an MGPS unless a permit has been issued. This includes all examinations where no interruption to the service is anticipated.

Organisation

10.7 Inspection and maintenance should be carried out using one of the following methods:

- a. on a contract basis by an approved specialist company registered to BS EN ISO 9000 (or BS 5750), with scope of registration defined to include maintenance of MGPS. Please see previous marginal note on the review of the concept of the existing QAS scheme;
- b. by properly trained hospital staff (essential for daily, weekly and other tasks);
- c. by a combination of (a) and (b) with a clear division of responsibility. For example, electric motors and water treatment apparatus maintained by hospital authority, the remainder maintained by contract.

10.8 The authorised person (MGPS) should be responsible for monitoring the maintenance work carried out by the contractor.

10.9 All work carried out should be subject to the permit-to-work system, and accepted by the authorised person (MGPS) prior to the contractor leaving site.

Preparation of a maintenance contract

10.10 This section is provided as guidance to the preparation of a maintenance contract for MGPS.

10.11 This section is intended to form part of the normal contract terms and conditions applicable to NHS trust contracts.

10.12 Recommendations are given for the requirements of contractors, procedures, method statements, the competency of the staff required to carry out the work and the responsibilities of trusts to monitor the work carried out.

10.13 It is a recommendation that all maintenance work on MGPS should only be carried out by specialist contractors who are registered to BS EN ISO 9000 with scope of registration defined to cover maintenance of MGPS and who can demonstrate compliance with the guidance given in this section.

10.14 It is the responsibility of the authorised person (MGPS) to satisfy themselves that the maintenance contractor is competent to carry out the work on the MGPS; this is implicit in the management of maintenance contracts for MGPS in order to ensure continuity of supply and patient safety. Patient safety is paramount when carrying out any work on an MGPS and should be given priority over cost, although it is recognised that contracts are managed to be as cost effective as possible.

10.15 A full record log of the maintenance carried out is to be kept on site and updated following any work; the contractor should be given a copy of the maintenance log.

10.16 The contractor should satisfy the trust that the maintenance tasks comply with the Pressure Systems and Transportable Gas Containers Regulations 1989.

10.17 Consideration should be given to the benefits that can be derived from longer contract terms between the client and the maintenance contractor.

General work procedures

10.18 All contractor's staff should report initially to the authorised person (MGPS) on arrival and also prior to departure from the premises. Visits to the location of supply plant and distribution equipment should not be made without the prior permission of the authorised person (MGPS).

10.19 The contractor should have made prior arrangement before each visit in order to minimise any disruption as much as possible.

10.20 While on the premises, the contractor should comply, and should ensure that his/her staff similarly comply, with the requirements of all relevant statutory safety legislation, including for example, the Health and Safety at Work etc Act 1974.

10.21 The contractor should at all times comply with the trust's safety policy, a copy of which should be signed by the contractor.

10.22 The contractor should provide his/her staff with appropriate identification acceptable to the trust which should be displayed at all times.

10.0 Maintenance

The trust may also issue its own identity or other pass which the contractor should display if so requested.

10.23 The trust will provide details of its fire policy and the contractor will be required to comply with this policy. The contractor should instruct his staff in the requirements of the fire policy.

10.24 The contractor should remove from the premises any of his staff if requested to do so by the authorised person (MGPS) or where the trust so requests on the grounds of efficiency, competence or public interest.

10.25 No work should be carried out, including examination of terminal units, unless a permit-to-work has been issued by the authorised person (MGPS) in accordance with the permit-to-work procedure.

Competency of contractor's staff

10.26 The contractor is responsible for ensuring that the staff working on any project are appropriately trained and qualified to carry out the work. The trust should not be required to test the competency of contractor's staff.

10.27 The trust may, however, request documentary evidence of competency and training. Practical evidence may be requested such as a demonstration of brazing competency.

10.28 As a minimum, the contractor's project manager who has overall responsibility for the maintenance services should have received specific training and have similar experience etc to fully understand the duties required of an authorised person (MGPS) as defined in HTM 2022.

10.29 The project manager should attend a refresher course at least every three years, as for an authorised person (MGPS).

10.30 The project manager should not only be familiar with the requirements of HTM 2022, but should have knowledge and experience in the implementations of relevant codes of practice, including for example, the Pressure Systems and Transportable Gas Containers Regulations 1989.

10.31 The project manager is responsible for ensuring that only suitable trained and experienced service engineers are employed who are familiar with HTM 2022 and the specialist techniques involved are employed on the maintenance contract.

10.32 The service engineers should have received at least the same training as would be required for a competent person (MGPS) as defined in HTM 2022.

10.33 The contractor should maintain a training programme and the training of each employee should be recorded in a training log.

10.34 The trust may request copies of the training log of any of the contractor's staff.

10.35 The contractor should assign a skill level to each of his/her staff, and this should be used when selecting the appropriate staff for a particular task.

10.36 An example of a training log form and a skills matrix form is given in Table 2.

Table 2 Training log and skills matrix

Form 1: Training log

Name:
 Position:
 Qualification:
 Experience:
 Summary of training to date:
 Training certificates:

Training course – title:
 Date:
 Type of training:
 initial course:
 refresher:
 re-assessment:

Description of training:
 authorised person (MGPS):
 competent person (MGPS):
 specific equipment:

Instructor/training course provider:
 Assessor:

Competence level

Current level of competence	Level after training
Trainee 0	Trainee 0
Level 1	Level 1
Level 2	Level 2
Level 3	Level 3

Instructor's comments/assessments

Line manager's comments/feedback

Signed by:.....
 Line manager/position.....

Date:

Form 2: Skills matrix

Assessment date	Issue no	Reference
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Engineer:		Current status: project manager senior service engineer service engineer competent person (MGPS) trainee
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Classification:

Trainee 0: Only to carry out work under the direct supervision of a competent engineer

Level 1: Qualified to carry out routine service, unsupervised, working to set procedures

Level 2: Qualified to carry out unsupervised services to set procedures and act on own initiative

Level 3: Qualified to carry out unsupervised maintenance and major repairs and modifications working to set procedures and on own initiative.

The contractor should identify the skill level associated with each task in the method statement, and allocate staff with appropriate skill levels to carry out the work.

10.37 Ideally, the contractor should only employ his own staff to carry out the maintenance services.

10.38 Where the use of sub-contract staff is unavoidable, the contractor should obtain prior permission from the trust to use such staff.

10.39 The contractor should ensure that any sub-contract staff are at least as competent as his own staff and have received appropriate training and experience.

10.40 The contractor should not allow any staff to work unsupervised on a site unless they have received the appropriate training as detailed in this section and in accordance with HTM 2022.

10.41 Where the contractor's staff are not familiar with the MGPS at the site, the authorised person (MGPS) should initially familiarise the contractor's staff with the site, prior to carrying out any PPM work.

Test equipment

10.42 The contractor should provide all appropriate test equipment. The test equipment should be in accordance with HTM 2022 'Design considerations'.

10.43 The test equipment should be calibrated in accordance with the manufacturer's recommendations, but in any case against NAMAS standards.

10.44 Calibration certificates should be available if requested.

10.45 When carrying out tests on terminal units, it is not sufficient to use only blank test probes. Such blank test probes should only be used for leak tests; a calibrated flowmeter and pressure gauge, together with appropriate calibrated jet, should be used to carry out flow and pressure drop tests.

10.46 The contractor should identify the test equipment appropriate to each task in the method statement – see paragraphs 10.59–10.62.

Services

10.47 The contractor should carry out the services specified in the contract on the dates or at the intervals specified in the contract.

10.48 A schedule of **minimum** tasks to be carried out, together with the **minimum** recommended frequency, is given in paragraphs 10.117–10.126. This may be modified by individual trusts as appropriate for their particular requirements.

10.49 Except where specifically provided for in the contract, and excluding emergency call-outs, all visits should be scheduled to take place on week days, between 08:30 and 17:00 hours.

10.50 It should be the responsibility of the trust to ensure that access to the plant and systems are available to the contractor.

10.51 The contractor should liaise with the authorised person (MGPS) to arrange for such access at least one week before the due date of the visit.

10.52 In addition to the tasks set out in this chapter, the contractor should replace wearing parts on a routine basis, but excluding the regular inspections of the vacuum insulated evaporator (VIE) and equipment operated from the pipeline system in accordance with paragraph 10.94 of this volume.

10.53 In addition to the regular maintenance programme set out in the schedule in Appendix I, the contractor should provide service engineers to carry out additional tasks as requested by the authorised person (MGPS). These tasks may be routine, non-urgent maintenance tasks, or may be emergency call-out tasks.

10.54 For non-urgent tasks, the extent, cost and time, and approximate duration of the work should be agreed between the contractor and the authorised person (MGPS) and confirmed in writing.

10.55 For emergency call-outs see paragraphs 10.71 to 10.78.

10.56 Prior to leaving site, on completion of the tasks, the contractor should report to the authorised person (MGPS) to sign off the permit-to-work and to provide any other information regarding additional work required, remedial work, faults found etc.

10.57 The authorised person (MGPS) should sign to the effect that the work has been carried out satisfactorily prior to the contractor leaving site.

10.58 It is the authorised person (MGPS)'s responsibility to satisfy himself/herself that the work has been carried out in accordance with the contract.

It may not be practical for access to operating departments and other high dependency areas to be available during normal working hours; in this case the Contractor should liaise with the authorised person (MGPS) to ensure that the work is carried out with due regard for the clinical requirements. Where access to such departments is routinely unavailable during normal working hours, this should be specified in the contract.

Method statement

10.59 A list of recommended tasks to be carried out at specified frequencies is given in Appendix I.

10.60 The tasks are listed as generic tasks. The contractor should prepare a method statement for each of the tasks identified.

10.61 The method statement will be applicable to the actual plant and equipment which is installed on a particular site.

10.62 The method statement should include the following information:

- sequence of tasks to be performed;
- procedures to be followed, for example permit-to-work, obtaining permission from ward staff, safety procedures etc;
- the grade, competency and number of staff to carry out the tasks;
- the test equipment to be used;
- the approximate time to complete the tasks;
- the documentation/report to be completed.

Records

10.63 The following records are to be completed following each and every visit to the premises, and after any work is carried out:

10.64 A signed and dated report form which includes the following details:

- company;
- time and date of arrival on site;
- trust order number;
- location, number and type of plant/equipment;
- details of work carried out, ie planned maintenance, breakdown, emergency call-out, etc – details of break down as reported, cause of breakdown, action taken;
- details of spares used;
- details of any further work required, urgency and implications;
- details of defects noted and remedial work required;
- time of leaving site;
- name of contractor's staff and grades;
- signatures: – contractor's engineers on site, authorised person (MPGS) for the trust on arrival and prior to departure, clinician/nursing officer for department visited.

10.65 For each area visited, the work record should be signed by the departmental manager, nursing officer or clinician as appropriate, with the time and date of the visit. This is to provide a written record that the particular department has been visited; it in no way implies any responsibility by the clinical or nursing staff with regard to the scope and effectiveness of the work

carried out. Variations in signature protocols should be agreed with the authorised person (MGPS).

10.66 A maintenance log is to be maintained for each plant item and is to be updated following each planned maintenance visit or any work carried out. The format of the maintenance log is to be specified by the authorised person (MGPS) and the log should be kept by the authorised person (MGPS). A copy will be made available to the contractor for his records if so requested.

10.67 Following the completion of the service, the contractor should affix a label to each plant item providing the following information:

- contractor's name, address and telephone number;
- the date the work was carried out;
- name and signature of service engineer;
- date of next planned service.

10.68 In addition, a barcode may also be affixed which is coded with the details of the service record.

10.69 It would not be practical to affix such a label to each terminal unit following planned maintenance. Therefore, a label giving the above information and the location of the terminal units should be affixed adjacent to the area valve service unit (AVSU) serving the area.

10.70 A schedule of the actual tests results for each terminal unit should be maintained and retained in the maintenance log.

Emergency call-out procedures

10.71 In addition to the planned maintenance tasks as specified in the contract and as recommended in Appendix I, the contractor should provide an efficient call-out service in the event of any breakdown or other incident occurring between planned maintenance visits.

10.72 This service should be available 24 hours per day, 365 days per year, including all bank holidays.

10.73 The exact procedure for initiating a call-out will vary with each trust. Each trust should, however, prepare appropriate procedures which should be set out in the operational policy and which should be agreed with the contractor and included in the contract documentation.

10.74 Typically, the trust should identify the person(s) responsible for contacting the Contractor (ie the authorised person (MGPS), shift engineer, duty engineer etc), the procedure for generating and authorising an official order for the work, and the procedures for obtaining access to the site at all times.

10.75 The contractor should, normally within a maximum of **one hour** of receiving an emergency call, contact the designated person. He should ascertain the nature and extent of the problem, and provide an estimate of the arrival time of a service engineer on site.

10.76 For emergencies which have or are likely to result in interruption to the supply or affect patient safety, the contractor should attend site **within a**

maximum time from receipt of the initial call as specified in the maintenance contract by the trust. The geographic location of the trust, number of trusts authorised and competent persons (MGPS), and availability of technical guidance are all considerations when defining the emergency response time. For normal circumstances a response time of **two hours** is recommended.

10.77 The contractor should be responsible for maintaining a reasonable stock of spares to facilitate emergency call-outs. The contractor should be familiar with each site and should therefore be able to reasonable anticipate the most likely spares which will commonly be required.

10.78 The contractor should submit with his tender a general statement on his capability to support the requirements of the trust. This should include details on the various resources available to him, number of staff employed, levels of competence, emergency support provision, and should define the level of technical advise and support that the contractor can provide. The contractor should also identify other similar contracts being undertaken.

Responsibilities of the trust to monitor the service

10.79 In order to ensure that the maintenance service is being carried out in accordance with the contract, the trust should monitor the work and the performance of the contractor.

10.80 The authorised person (MGPS) should have responsibility for the satisfactory implementation of the maintenance service.

10.81 The authorised person (MGPS) should ensure that the contractor's staff and performance are checked on a random basis. On a large site, it may be desirable to carry out a maintenance audit at least every six months.

10.82 The authorised person (MGPS) should ensure that the service engineer has adequately reported any defects or remedial work required prior to leaving site.

10.83 The authorised person (MGPS) should arrange site meetings when necessary with the Contractor's representatives to discuss progress. Meetings will normally be arranged if the trust is not satisfied with the level or standard of service, or if changes in contract details are required.

10.84 The contractor's project manager should be present at such meetings, together with the service engineers as appropriate.

10.85 The contractor's agreed attendance at progress meetings should form part of the contract.

Preparation of a PPM schedule

General

10.86 This section gives recommendations for the minimum tasks at the minimum recommended frequency in order to ensure that the appropriate PPM procedures are applied to MGPS to secure continuity of patient safety. It is intended to be applicable to all MGPS, whether new or existing installations,

irrespective of whether or not the systems comply with the recommendations in HTM 2022.

10.87 All work should be carried out in accordance with HTM 2022 and C11 as appropriate.

10.88 Appendix I gives specific recommended checks on the MGPS, including particular details of daily and weekly test recommendations. These tasks are usually carried out by the trust, however the trust may wish the contractor to carry out these tasks as an additional contract.

10.89 Appendix I provides a recommended schedule of services for the MGPS based on quarterly and, where appropriate, annual tasks.

10.90 In conjunction with the manufacturer's recommendations, the guidance given in these sections should enable a PPM schedule to be prepared; or enable management to scrutinise a contractor's proposals with ensure compliance with these recommendations.

Preparation

10.91 The suppliers should be required to provide complete "as-fitted" drawings, circuit diagrams, valve charts and maintenance instructions, which should be used as the foundation for the PPM programme. For new plant the PPM programme supplied by the manufacturers should be used. The terms used in the PPM programme and their definition are as follows:

Examine	To make a careful and critical scrutiny of an item without dismantling, by using the senses of sight, hearing, smell and touch, to verify that the plant or equipment is in working order.
Test	To operate the plant or equipment and/or use the appropriate testing instruments to ensure that plant or equipment is functioning correctly.
Check	To make a thorough inspection for damage, wear or deterioration. Also to ascertain that the plant or equipment is correctly adjusted to conform to the required standard.

10.92 The actual frequency of maintenance routines should be established from the manuals for the equipment and plant. Practical experience with equipment of different manufacturers, and information from plant history logs, might well result in the need to vary some frequencies and tasks in particular installations.

Specific maintenance checks

Overhauls

10.93 In addition to the examination, tests and checks set out in the PPM programme, arrangements should be made for a general overhaul of all MGPS in conjunction with the manufacturer's recommended frequency. This is likely to involve a temporary changeover to the emergency stand-by manifold (ESM) cylinder gases during the overhaul of the compressors.

Exclusions

10.94 The PPM programme does not cover the regular inspections considered essential for the safe operation of bulk liquid oxygen installations.

Records and plant history logs

10.95 The results of each inspection, and any action taken to correct faults found during the inspection, should be recorded. Arrangements should be made so that action can be instituted to correct apparatus giving constant trouble caused by faulty design or by unsatisfactory conditions of any nature. Provision should be made for maintenance tasks and their frequency to be modified when necessary.

10.96 Counters which record the hours of operation of each compressor and vacuum pump have been suggested in Chapter 7 of 'Design considerations'. The readings of these counters can be used in conjunction with the recommendations of the manufacturers for the modification of the programme.

Equipment checklists

10.97 The installations include a great number of AVSUs, pressure-regulating valves, filters, indicating lights and audible alarms. Equipment checklists should be prepared for each of these groups of items. AVSUs and pressure-regulating valves should be referred to by number in the checklist, and this number should correspond with that on the valve itself. It is usually convenient to arrange these checklists in such a manner that a record can be made against each valve showing whether it has been "examined", "tested" or "checked" in accordance with the PPM programme.

Maintenance of filters

10.98 It is not possible to specify in advance the frequency with which the various filters on the MGPS should be cleaned or changed. Inspection should be in accordance with the manufacturer's recommendations and take account of local conditions.

Plug-in type terminal filter assemblies used in association with breathing systems do not form part of the MGPS. AGSS are prone to collecting lint which blocks filters and affects performance.

Maintenance of blenders

10.99 Maintenance should be carried out in accordance with the manufacturer's instructions.

Maintenance of compressed air dryers and pressure swing adsorber (PSA) columns

10.100 It is not possible to specify the frequency with which air dryer desiccant charges or PSA columns should be replaced. The desiccant should be checked at intervals and by methods recommended by the supplier. The charge should be replaced with the appropriate material in accordance with the recommendations of the supplier. A record of the type, batch number of desiccant and date of change should be kept.

10.101 The quality of gas from PSA and medical air compressors should be tested quarterly, in accordance with the procedures in 'Design considerations'.

Maintenance of medical gas manifolds

10.102 The engineer should examine the effectiveness of the various pressure regulators each day by observation of the supply pressure gauges and, simultaneously, ensure that any indicating lights show the actual condition at the time of this routine inspection. If any manifold is observed to be in operation on its "reserve" bank, he/she should ensure that replacements for the empty cylinders will be available in good time.

Maintenance of equipment for use with gas cylinders

10.103 Equipment for use with medical gas cylinders, including piped medical gas distribution systems, should be subject to routine inspection and maintenance in accordance with the manufacturer's recommendations and, where appropriate, it should be subject to PPM (advice is given in HEI 98). Maintenance work must be carried out only by competent and qualified staff.

Maintenance of bulk liquid oxygen (VIE) systems

10.104 VIE maintenance is the responsibility of the gas supplier, but there are customer checks which should be carried out daily and weekly. In addition, it may be necessary to test the warning and alarm system.

10.105 In this case each alarm condition is initiated by the operation of a pressure switch. The control panel is supplied with three-way ball valves on the oxygen supply lines to each pressure switch. Rotation of these valve handles through 180° allows oxygen pressure to the pressure switches to be reduced. This action operates the pressure switches and the hospital alarms.

10.106 Weekly customer checks should be carried out by the hospital as follows:

- a. check mechanical joints for obvious signs of leaks;
- b. check for mechanical damage;
- c. check that the pressure setting of the VIE inlet is set at 10.5 bar g;
- d. check that the pressure setting of the distribution pipeline is set at 4.2 bar g;
- e. where cylinder back-up is used, check that the pressure of the cylinders on the reserve manifold is above 68 bar g;
- f. where liquid back-up is used, check (a) and (b) above and that the back-up vessel is set at 8.5 bar g;
- g. ensure that there is no build up of rubbish/flammable material within the vessel compound.

10.107 The VIE reserve manifold needs to be checked weekly. This is particularly important, since the emergency manifold is very rarely used and a small leak can lead to the loss of a cylinder bank. In particular, the pressure of the reserve manifold cylinders should be checked weekly, as described in the above list.

10.108 In the event of an emergency, the authorised person (MGPS) should be aware of how to shut down the VIE system and the consequences of such action.

*Relevant SHHD circular –
1977(GEN)68 and 1979(GEN)40.
Not adopted in Scotland.*

*The high line pressure alarm requires
specialist test equipment – contact
the gas supplier.*

Medical vacuum systems: bacteria filters – standard operational procedure for filter changing

General

10.109 Before carrying out any work on bacteria filters, the user is to advise on any toxic or infectious materials which may have been used and on appropriate precautions to be observed.

10.110 All staff, including contractors, should observe safety procedures as set out in the trust's safety policy.

Permit-to-work

10.111 A valid permit-to-work form for safety purposes (this is not the same as the medical gases permit-to-work form) must be authorised by the trust's staff (usually the authorised person (MGPS)) before a filter is changed.

10.112 Where appropriate, a contractor's permit-to-work must be issued and appropriately annotated.

Medical vacuum – bacteria filter change

10.113 It is safe to change the filter provided the procedures in this standard operational procedure are observed.

Protective clothing

10.114 All staff should wear the following protective clothing when carrying out a filter change:

- a. disposable mask incorporating a filter;
- b. disposable overalls;
- c. disposable gloves made of strong latex;
- e. disposable overshoes;
- f. safety goggles.

*It is assumed that the occupational exposure limit for all toxic substances will not be exceeded. If this is **not** the case, the safety officer should be advised and an appropriate air-fed respirator should be used.*

10.115 All disposable protective clothing, that is, mask, overalls, gloves and overshoes, are to be placed in the outer bag for disposal.

Filter disposal

10.116 The following procedures should be observed:

- a. the used filter is to be placed directly into a heavy-duty polythene bag;
- b. this bag is to be placed inside a second bag, which is also sealed and labelled "hazardous waste – to be incinerated";
- c. the staff carrying out the filter change are to notify the waste disposal department and/or the authorised person (MGPS), as appropriate, so that the bags can be collected and disposed of.

Schedule of maintenance services

General

10.117 This generic schedule of services is based on quarterly service visits.

10.118 The tasks listed under each item are to be carried out during every quarterly visit.

10.119 In addition to the quarterly tasks, additional tasks should be carried out annually, and these are listed separately.

10.120 For terminal units, the tasks listed should be carried out at a frequency specified by the trust, taking into account the amount of daily use the terminal unit undergoes, and also the age and design of the terminal units. As a minimum the work should ideally be scheduled such that one quarter of the terminal units are serviced during each service visit.

10.121 For each of the tasks listed here, where adjustments or other remedial actions are required this should be carried out at the time; where such action is not possible, for example where additional parts are required, this should be noted and reported to the authorised person (MGPS).

10.122 There are also statutory requirements with regard to pressure vessels and inspections; these tasks are not included here.

10.123 It is not recommended that safety valves are lifted; every safety valve should have a test certificate in accordance with HTM 2022. The safety valve should be replaced every five years under a planned replacement procedure.

10.124 Statutory obligations under the Pressure Systems and Transportable Gas Containers Regulations require the periodic testing of pressure safety devices. It is not appropriate to test a medical gas pipeline system by either raising the line pressure regulator setting or manually unseating the relief valve. Such action could result in failure of anaesthetic equipment, and in the event of failure of the safety valve to re-seat, considerable gas loss and further hazard. Medical gas pipeline line distribution systems should be provided with a pressure relief device downstream of the line pressure regulator connected by means of a three-way cock so that the safety device can be exchanged for a "certificated" replacement in accordance with the frequency required by the Regulations.

10.125 The following services are covered in this schedule:

- a. general safety requirements;
- b. medical compressed air and surgical air plant;
- c. medical gas manifolds;
- d. emergency reserve manifold;
- e. medical vacuum plant;
- f. pipeline distribution system;
- g. warning and alarm systems;
- h. anaesthetic gas scavenging systems (AGSS);
- j. yearly tasks – in addition to quarterly tasks.

11.0 Risk assessment – control of exposure to anaesthetic agents

General

11.1 Anaesthetic gases are considered to be substances hazardous to health for the purposes of the Control of Substances Hazardous to Health Regulations 1988 (COSHH), except where they are administered to a patient in the course of medical treatment.

11.2 The COSHH regulations set out very specific duties that apply to the handling of anaesthetic gases, and employers have a legal obligation to ensure that these duties are discharged. It is therefore the responsibility of the general manager or chief executive to implement the requirements of the COSHH regulations with respect to anaesthetic gases.

11.3 The anaesthetic gases which are of primary concern are nitrous oxide and halogenated agents such as halothane and isoflurane. These agents are usually administered in low concentrations compared to nitrous oxide. Therefore, for practical purposes, it is only necessary to consider the effects of nitrous oxide pollution.

11.4 The COSHH regulations require that, for every exposure to substances hazardous to health, the following should be carried out:

- a. assessment of the risk;
- b. methods of achieving control of the risk;
- c. means of monitoring that the methods of control are maintained in an effective condition.

Risk assessment

11.5 The risk assessment will be based on the exposure limits that came into effect on 1 January 1996, published by the Health and Safety Executive, for nitrous oxide and the halogenated anaesthetic agents.

11.6 Detailed guidance on compliance with COSHH is given in EL(96)33, covering publication; 'Advice on the Implementation of the Health & Safety Commission's Occupational Exposure Standards for Anaesthetic Agents, published by the Department of Health 1996'. Further guidance is given in 'Anaesthetic agents: Controlling exposure under COSHH', prepared by the Health Services Advisory Committee, ISBN 0-7176-1043-8.

11.7 Employers – in this case executive managers – have a statutory obligation to ensure that these levels are complied with in accordance with the COSHH regulations.

11.8 The published exposure limits have been shown to be achievable in areas where the maximum exposure to anaesthetic gases is likely to occur, that is, operating theatres and anaesthetic rooms.

11.9 Assessment of the risk will involve the following:

- a. identifying areas where exposure to anaesthetic gases can take place, and listing them in rank order, taking into account the likely exposure and duration – the worst areas are, therefore, the operating room and the anaesthetic room;
- b. examination of the methods of control currently installed – for example if a scavenging system is installed, its effectiveness will need to be established. It will probably be necessary to carry out monitoring of both the environment and exposed personnel in order to establish a base level. Where there is any doubt as to the effectiveness of an installed scavenging system, sampling of the environment together with personal samples of the anaesthetist and other staff who may be exposed to high concentrations, should be carried out. Where no scavenging system is installed in high risk areas, sampling of the environment should be carried out in order to assess the need.

Methods of control

11.10 Effective control of exposure to anaesthetic gases will involve a combination of the following measures:

- a. the use of an effective scavenging system to remove the pollution at source;
- b. good room ventilation to dilute pollution from leaks, patients' expired air etc;
- c. good housekeeping to minimise leakage, such as from poorly-fitted face masks, flowmeters inadvertently left on, poorly-maintained anaesthetic or scavenging equipment.

11.11 A scavenging system which complies with BS 6834:1987 should be installed in all new operating rooms and anaesthetic rooms. Where a scavenging system is already installed which does not comply with BS 6834:1987, its effectiveness should be assessed initially by monitoring the environment and by personal sampling. If the exposure exceeds a TWA of 100 ppm for nitrous oxide, consideration should be given to installing a system which complies with BS 6834. It should be emphasised, however, that the actual exposure is likely to be the result of pollution from several sources, such as leakage, and therefore the ventilation system and the maintenance of equipment should also be included in the assessment.

Scavenging systems which conform to BS 6834:1987 are only appropriate for installation in operating rooms and anaesthetic rooms and should not be installed in other areas.

11.12 Anaesthetic gases are also administered in other areas such as maternity departments and dental clinics. In these areas there is currently no effective scavenging system available, and therefore a combination of good ventilation and good housekeeping will be required to minimise the exposure to anaesthetic gases. This also applies to recovery areas, where the concentrations expired by the patients are relatively low and no satisfactory scavenging system is available. Guidance on ventilation systems is given in HTM 2025. An air change rate of 15 air changes/hr is recommended for recovery areas.

Monitoring

11.13 Good housekeeping will be required in order to minimise leaks from equipment, poorly-fitting face masks, flowmeters left on unnecessarily, etc. The co-operation of all staff will be required to maintain a consistent

11.0 Risk assessment – control of exposure to anaesthetic agents

minimum exposure; this will require periodic monitoring and training for all staff.

11.14 The scavenging system should be tested in accordance with Chapter 15 of 'Design considerations'.

11.15 The co-operation of all staff – clinicians, nurses, theatre technicians, estates staff – will be required in order to achieve compliance with these requirements.

11.16 It is therefore recommended that one person should be nominated by the general manager/chief executive to have responsibility for implementing these recommendations and co-ordinating a monitoring and training policy.

11.17 A monitoring programme should include the following:

- a. initial assessment of staff exposure;
- b. routine measurement of staff exposure;
- c. testing of scavenging systems;
- d. testing of ventilation systems.

11.18 An initial assessment of the actual staff exposure levels should be carried out either by monitoring the environment or by personal sampling of staff. This sampling should include staff in all areas where anaesthetic gases and agents are used, including areas where it is not possible to install a scavenging system, for example delivery rooms.

11.19 If the initial assessment shows higher exposure levels than would be expected, real-time monitoring of the environment may be required in order to establish the source of the pollution.

11.20 Personal sampling may be required routinely.

Methods of personal sampling are currently being investigated.

12.0 Definitions

Definitions

Anaesthetic gas scavenging system (AGSS): A complete system which conveys expired and/or excess anaesthetic gases from the breathing system to the exterior of the building(s) or to a place where they can be discharged safely, for example to a non-recirculating exhaust ventilation system.

Area valve service unit (AVSU): A valve assembly within an enclosure provided for maintenance or for connecting a temporary supply or, in emergency, for shutting off the gas flow to a specific area or for the purging and testing of gas supplies after engineering work.

Authorised person (MGPS): A person who has sufficient technical knowledge, training and experience in order to understand fully the dangers involved and who is appointed in writing by the executive manager on the recommendation of a chartered engineer with specialist knowledge of MGPS. The certificate of appointment should state the class of work which the person is authorised to initiate and the extent of his/her authority to issue and cancel permits-to-work.

The authorised person (MGPS) should have read, have understood and be able to apply the guidance in HTM 2022, especially in relation to validation and verification, and should also be completely familiar with the medical gases pipe routes, their means of isolation and the central plant. He/she should ensure that the work described in any permit-to-work is carried out to the necessary standards.

Batch number: A distinctive combination of numbers and/or letters which specifically identifies a batch or lot and permits its history to be traced.

Client's representative: The person, or that person's representative, as defined under the designated Standard Form of Building Contract issued by the Joint Contracts Tribunal 1980 (JCT 80).

Competent person (MGPS): A person having sufficient technical knowledge, training and experience to carry out his/her duties in a competent manner and understand fully the dangers involved, and whose name is on the register of competent persons. The register should be maintained by either a specialist contractor or by the authorised person (MGPS) as appropriate. See also the definition of a contractor and paragraphs 5.33–5.35.

He/she should be familiar with and able to read the record drawings and should have received specific training on MGPS.

He/she should be able to identify all types of medical gases terminal units and should be familiar with all testing and commissioning procedures referred to in HTM 2022. The person maintaining the register should assess a person's competence, taking account of his/her training and experience.

Competent person (Pressure Systems) as defined by the Pressure Systems and Transportable Gas Containers Regulations 1989. In the regulations three

12.0 Definitions

categories of system are defined and for each category different attributes are required for competent persons:

- a. minor systems: pressure less than 20 bar (2.0 MPa.) and the pressure volume product for the largest vessel should be less than 2×10^5 bar-litres (20 MPa. m^3);
- b. intermediate systems: these include systems that do not fall into either of the other two categories;
- c. major systems: steam-generating systems exceeding 10 MW, pressure storage systems in excess of 10^6 bar-litres (100MPa. m^3);

Most MGPS will fall into the minor systems category.

A full list of the attributes required is given in the Regulations, but in summary, minor systems require at least incorporated engineer status while intermediate and major systems require chartered engineer status.

Contract: The agreement concluded between the trust and the contractor, including all specifications, contractor's samples, plans, drawings and other documentation which are incorporated or referred to therein.

Contract supervising officer: The person authorised by the hospital authority to witness tests and checks under the terms of contract. He/she should have specialist knowledge, training and experience of MGPS and HTM 2022.

Contractor: The contractor commissioned typically as a sub-contractor for the installation of the MGPS under the Standard Form of Building Contract issued by the Joint Contracts Tribunal 1980 (JCT 80). All contractors working on MGPS should be registered to BS EN ISO 9000 with scope of registration defined as appropriate.

Decanting: The act of transferring oxygen under pressure, normally from a large cylinder to a smaller, usually transportable one. This procedure should only be carried out under controlled and documented conditions with the sanction of the quality controller (QC).

Designated medical and nursing officer: The medical or nursing officer designated by the chief executive to act as a focal point for communications related to MGPS in a specified department or departments. There would ideally be a designated medical officer and a designated nursing officer in each department. The designated officer should give permission for any interruption to the MGPS.

Designated person: A suitably trained person who has been given responsibility for a particular operation involving medical gas cylinders, for example responsibility for changing cylinders on the MGPS manifold.

Equipment: A device, such as a pressure regulator and flow meter, which is connected to a single cylinder for the administration of medical gas to an individual patient or gas apparatus.

Flammable: Capable of burning with a flame.

HTM 22: Hospital Technical Memorandum 22 – 'Piped medical gases, medical compressed air and medical vacuum installations' (first published by HMSO for the Department of Health and Social Security as Hospital Technical

Memorandum 22 in May 1972, and as amended by HN(76)175), and last reprinted in 1978 with minor corrections.

Main cylinder storage area: The main area where all cylinders on a site are stored, excluding only those cylinders in use in manifold rooms or in ready-to-use stores.

Manifold room: A purpose-built room designed to accommodate a cylinder manifold installation and reserve cylinders as appropriate.

Medical gas pipeline systems (MGPS): The fixed medical gases pipeline and the associated supply plant or pumping equipment and warning and alarm systems. This definition includes medical compressed air and medical vacuum installations and anaesthetic gas scavenging systems.

Permit-to-work: A form of declaration or certificate in six parts, for signature as appropriate. It states the degree of hazard involved, defines all services to be worked on and the points where isolation of the affected sections are carried out. It also gives an indication of the work to be carried out. It is not a permit for the use of the installation for clinical purposes until all parts have been completed. A pro-forma is given in the permit-to-work section of Chapter 6 "Operational procedures".

Pipeline carcass: The pipeline installation with terminal unit base blocks and area valve service units (excluding pressure switches, flexible assemblies, etc).

Pipeline manifold: A pipe to which cylinder tail-pipes are connected, which in turn is connected to the control equipment by means of which medical gas is delivered to the MGPS.

Premises: The premises should be the hospital site, healthcare building or other establishment where the MGPS is installed and the services are to be provided, as defined in the contract.

Pressure safety valve: A valve to limit pressure within the pipeline system.

Pressure swing adsorber (PSA): Medical oxygen concentrator. System comprising compressor(s), nitrogen adsorber unit(s) and reservoir by means of which oxygen-enriched, clean, dry, oil-free air is generated from atmospheric air.

Procedure: A written method which has been drawn up by a person familiar with the system and the requirements of this HTM, and checked by the QC or authorised person (MGPS), as appropriate. It should be signed by both persons and be dated, and include a review date.

Protective cover: A tamper-evident means of protection of the cylinder valve or valve gas-outlet which may be achieved by a viscose seal, plastic cap or metal cover.

Quality controller (QC): A person appointed in writing by the executive manager on the recommendation of the chief pharmacist. The QC should normally be a pharmacist or other suitably qualified person and should have specialist knowledge, training and experience of MGPS and HTM 2022. The QC is responsible for the quality of the medical gases; his/her duties include carrying out the quality tests in accordance with the procedures specified in "Validation and verification".

12.0 Definitions

Ready-to-use store: A local subsidiary to the main store for a limited number of medical gas cylinders, usually cylinders for immediate use and one day's supply for reserve purposes.

Services: The services means the services and the goods which the contractor is required to supply in accordance with the contract.

Specialist fire safety advisers: This post is fully described in 'Firecode: Policy and principles'.

Tail-pipe: A flexible connecting pipe which connects a medical gas cylinder to a medical gas pipeline manifold via a gas-specific connector.

Training (gas cylinders): Formal instruction in the safe handling and storage of gas cylinders and associated equipment to ensure that all staff are aware of the dangers involved and will act accordingly.

Trust: Trust means the NHS trust, Special Health Authority or other Health Authority as appropriate.

Vacuum insulated evaporator: Cryogenic liquid system, source of supply containing liquefied gas stored under cryogenic conditions.

Appendix I – General safety requirements

The following should be checked and any deficiencies or remedial action required should be notified to the authorised person (MGPS):

- a. safety notices – appropriate notices clearly displayed in all plantrooms and cylinder stores;
- b. “no smoking” notices – clearly displayed;
- c. discharge points/vents/vacuum/AGS – warning notices clearly displayed;
- d. motor guards in position and in good repair;
- e. notices warning of automatic start-up in position and legible;
- f. plantrooms free from combustible material and with adequate access for maintenance;
- g. all cylinders properly stored/secured and all batch labels correct and in date.

Medical compressed air and surgical air plant

Note: this applies to surgical air systems except that these may be simplex systems.

Compressor units

- Examine: general condition of unit
silencers
alignment of compressor and motor – adjust as necessary
safety valves (do not lift) and discharge vents
drainage traps
level of lubricants – replenish/completely replace as necessary
condition and running of cooling fans – replace as necessary.
location of air intakes – report as necessary
- Check: air intakes and air filters– clean and replace as necessary
security of all holding-down bolts
condition of anti-vibration mounts – replace as necessary
compressor(s) and motors are secure
belts, pulleys and drive couplings – adjust/replace as necessary
flexible connections thermostatic control – replace as necessary
oil filters
- Test: operation of plant
operation of pressure gauges – replace as necessary
for any unusual noise
record plant conditions including standby cut-in settings etc
operation of coolers

Receiver(s)

- Examine: general condition
safety valves for leakage
security of holding-down bolts
condition of isolating valves
condition of flexible connections
- Check: pressure gauges
pressure switches – adjust as necessary
operation of non-return valve
operation of drainage trap
safety valve discharge vent
- Test: operation of pressure gauges – replace as necessary

Separators and filters

- Examine: condition of separator
condition of drainage trap
- Check: isolating valves
filters

Dryers

- Examine: general condition
heating elements or air-dried columns as appropriate
- Check: operation of heating elements/thermostats as applicable
automatic release of air prior to drying process
automatic re-pressurisation following drying process
correct sequencing between columns on automatic/manual desiccant
- Test: operation of pressure sensing devices
operation of all automatic valves
operation of dew-point sensor

Compressor control panel

- Examine: condition of control cabinet
condition of electrical conduits
earthing/continuity arrangements
- Check: security of electrical connections
operation of pressure sensors
terminal connections
condition of cables
operation of high- and low-pressure switches
operation of starter and overloads
operation of lamps and warning devices
- Test: operation of duty selector switch
operation of auto/manual selector
operation of main isolation switches

Pressure regulators

- Examine: condition of all pressure regulators
- Check: safety valves
regulator mountings
locking devices where fitted
operation of gauges
- Test: operation of regulators – adjust as necessary
correct settings – adjust as necessary

Warning and alarms system

- Test: operation of all alarms – adjust as necessary

Compressor system

- Test: operation of plant by simulation of running and fault conditions
system pressure
quality of medical air to HTM 2022 quality specification

Record details of all plant data, including hours run, start-up/run current, cut-in and cut-out pressure switch settings etc.

Medical gas manifolds

Cylinder racks

Check: damage, security and general condition

Headers

Check: for damage
non-return valves for leakage and operation

Tail-pipes

Examine: general condition
threads on tail-pipe header connection

Check: for leakage – replace tail-pipes and non-return valve seals as necessary

Control panel

Note: the detailed tasks will depend on the type of panel installed. The manufacturer's recommendations should be followed in all cases. The tasks listed here are generic, and the actual tasks should be detailed in the method statement.

Examine: general condition
leakage
earthing/continuity arrangements

Check: electrical connections
fuses
operation of isolating valves
safety valve for leakage
safety valve discharge vent for blockage
pressure regulator settings – adjust as necessary
lamps and warning devices

Test: pressure gauges
operation of automatic changeover device
operation of manual changeover device
operation of pressure regulating devices
pressure regulators for creep

Emergency reserve manifold

Examine: condition of cylinders
leakage at connections
condition of tail-pipes – replace as necessary

- Check: security of fixings
 operation of isolating valves
 operation of pressure regulator
 safety valve for leakage
 safety valve discharge vent
 cylinder valves open or closed depending on automatic/manual system
 at least one cylinder valve is open
 emergency standby manifold (ESM) isolating valve is closed
- Test: pressure gauges
 pressure regulator within specified limits
 pressure regulator for creep

Medical vacuum plant

Vacuum pumps

- Examine: general condition
 alignment of pump and motor
 lubricant levels – top up as required/totally replace
 condition of flexible connections
- Check: security of holding-down bolts
 condition of anti-vibration mounts – replace as necessary
 motor and pump are secure
 belts, pulleys and drive couplings – adjust/replace as necessary
- Test: operation of pressure sensing devices
 for unusual/excessive noise

Receiver(s)

- Examine: general condition
 security of holding-down bolts
 condition of delivery isolation valve
 condition of flexible connections
- Check: pressure gauges
 pressure switches
- Test: operation of non-return valves

Drainage traps and filters

- Examine: condition of all filters – replace as necessary
 provision of traps – advise accordingly
- Check: operation of isolation valves
 pressure differential across filters (where possible)
 sight glass

Control panel

- Examine: condition of control panel
condition of electrical conduits
earthing/continuity arrangements
- Check: electrical connections
operation of pressure devices
terminal connections
cable condition
operation of starters and overloads
lamps and warning devices
- Test: operation of duty selector switch
operation of auto/manual operating switch
operation of main isolation switches

Exhausts

- Examine: location – potential hazards
flexible connections
silencers
security of bracketing
discharge point for blockage
- Check: drainage traps and flasks – empty as required and rectify fault or report remedial action necessary

Vacuum plant system

- Test: operation of plant
record plant settings eg standby pump cut-in pressure etc
operation of all warning and alarm systems

Pipeline distribution system

Pipework

- Examine: labelling
bracketing
damage
proximity to other services
no modifications/other hazards since last examination

Valves – isolating

- Check: valves are operational and are correctly orientated
valves are locked (where appropriate)
valves are labelled correctly

AVSUs

Examine: location
cleanliness – clean as required

Check: correct labelling – rectify as necessary
orientation of on/off valves
valves for ease of operation

Pressure reducing sets

Examine: condition of all pressure regulators

Check: safety valves
security of regulator mounting
locking devices – where fitted

Test: regulators for creep
regulators for correct settings

Terminal units

Examine: general condition

Check: no leakage occurs when blank probe is inserted or removed – repair as necessary
identification markings are secure and legible
security of mountings

Test: operation using test probes
gas specificity using gas specific probes
pressure with no flow
pressure under design flow conditions using calibrated test equipment
flow rate

Pendants/booms

Note: the actual tasks required to test the performance of the pendants will depend on the design of the system. In each case, the full range of performance characteristics should be covered. For example, some pneumatically controlled pendants have rotational as well as vertical movement, and this should be tested; the braking system (where applicable) and the fail-safe devices (such as remote controllers) should also be covered. The advice of the manufacturer should be followed.

Examine: security of fixings/mountings
freedom of movement as applicable
labelling and colour coding of hose assemblies

Check: leakage
hose assemblies – security of crimping/ferrules etc
condition of hoses – replace as necessary

Test: terminal units as above

Warning and alarm systems

Central alarm system – all panels

- Examine: general condition
location
mains electrical supply
- Check: operation and automatic reset of muting devices
electrical connections
markings and labelling – legibility of fault conditions
fuses
- Test: lamps/LEDs for function
operation of flasher unit where fitted
condition of batteries
condition of low voltage transformer
operation of circuit fault alarm
function of audible alarm
correct indication under fault conditions

Area alarms

- Examine: general condition
location and areas served
mains electrical supply
- Check: as for central alarms
- Test: as for central alarms
operation of line pressure sensors

Note: it may be necessary to simulate these fault conditions.

Anaesthetic gas scavenging systems (AGSS)

Pump units

- Examine: general condition
location of discharge
security of fixing devices
anti-vibration mountings
flexible connections
- Check: lubricant levels – replenish/replace as necessary
electrical connections
condensate drain – empty as necessary
balance valves are not obstructed and are operating correctly –
clean filter as necessary
correct rotation of pumps
exhaust is free from obstruction
starter and overload
lamps and warning devices

Test: operation of plant from remote controllers
appropriate alarm condition is indicated – simulated flow failure
pressure sensing devices
operation of changeover from duty to stand-by on duplex systems

AGS terminal units

Examine: general condition
location

Check: labelling
function – clean and adjust bobbin assembly or orifice as appropriate

Test: correct flow and pressure using calibrated test equipment

AGS receiving system (where included in contract)

Examine: general condition
location
flexible connecting hoses – replace as necessary

Check: filter for fluff etc and clean as necessary
air inlets are not obstructed
correctly labelled

Test: operation of flow indicator

Yearly tasks – in addition to quarterly tasks

Distribution system

Pipework

Examine: examine the complete pipework distribution system for signs of damage

Check: accuracy of as-fitted drawings
identification markings, labelling etc

Pressure reducing sets

Check: valves for pressure creep
safety valves – see paragraph 10.124, this volume

Pendants/hose assemblies

Check: condition of hoses and hose connections
see also note under pendants – it may be necessary to dismantle the pendant assembly in order to fully check the hoses.

Manifold systems including emergency supply systems

Tail-pipes – replace

Control panel safety valves – see paragraph 10.124, this volume

Medical compressed air plant – including surgical air plant

Compressor units

Examine: inter-cooler and/or after-cooler for cleanliness of fans – clean and/or replace as necessary

Check: blow out and check motor windings and bearings

Dryers

Check: condition of desiccant – replace as required

Pressure regulators

Check: regulators for pressure creep
safety valves – see paragraph 10.124, this volume

Electrical system

Test: carry out resistance tests on electrical circuits

Appendix II – Procedure for breaking into an existing system

4.1 Figure 3a indicates an assembly comprising a valve (in a box) and pipe drops, with pipe joints brazed with copper fittings. It is fully tested and purged with medical air in preparation for final connection into an existing system. Final purging with the working gas may be accomplished after connection to the existing installation.

4.2 If further work is to be undertaken downstream of the valve, the physical break point incorporated in the AVSU should be used downstream of this valve (see Figure 3b). The pipe tail upstream of the physical break point should be capped with a plastic cap. This section downstream of the break point will require a pressure-tight capping, so that full pressure testing and purging with medical air of this section may be undertaken. A blank plug is available for this purpose.

4.3 It is not always necessary to provide a valve for the isolation of a section which has to be worked on. For example, where a simple extension is required, as in Figure 3c, a physical break point is established, the upstream side of the break is capped with a blank plug, and the remainder of the system can be taken back into use.

4.4 Unless it is possible to use the physical break points in the AVSUs, there will always be one joint which has to be brazed without an inert gas shield. This should be purged fully with the working gas before the system is tested for quality and identity.

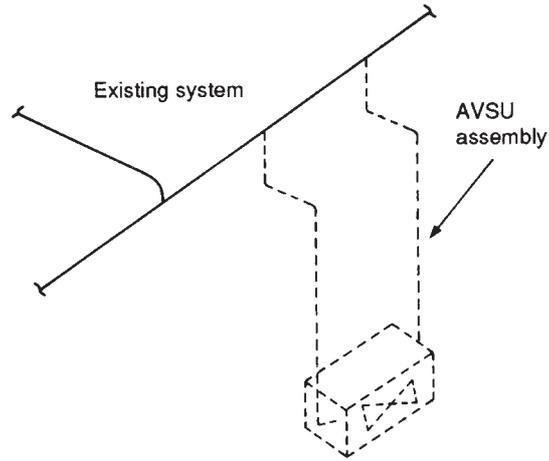


Figure 3a

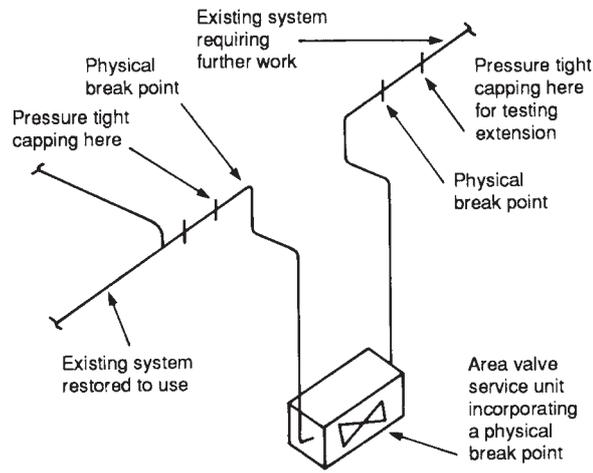


Figure 3b

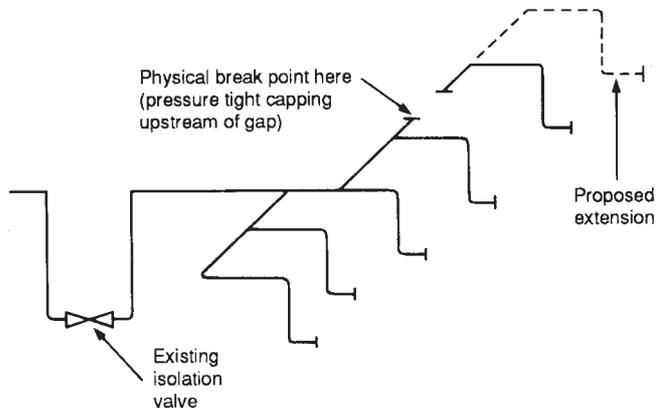


Figure 3c

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(Given below are details of all Health Technical Memoranda available from HMSO. HTMs marked (*) are currently being revised, those marked (†) are out of print. Some HTMs in preparation at the time of publication of this HTM are also listed.)

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- 2 Anti static precautions: flooring in anaesthetising areas (and data processing rooms), 1977.
- 3–4 –
- 2005 Building management systems, 1996.
- 6 Protection of condensate systems: filming aminest
- 2007 Electrical services: supply and distribution, 1993.
- 8 –
- 2009 Pneumatic air tube transport systems, 1995.
- 2010 Sterilizers, 1994, 1995, 1997
- 2011 Emergency electrical services, 1993.
- 12 to 13 –
- 2014 Abatement of electrical interference, 1993.
- 2015 Bedhead services, 1994, 1995.
- 16 –
- 17 Health building engineering installations: commissioning and associated activities, 1978.
- 18 Facsimile telegraphy: possible applications in DGHs†
- 19 Facsimile telegraphy: the transmission of pathology reports within a hospital – a case study†
- 2020 Electrical safety code for low voltage systems, 1993.
- 2021 Electrical safety code for high voltage systems, 1993, 1994.
- 2023 Access and accommodation for engineering services, 1995.
- 2024 Lifts, 1995.
- 2025 Ventilation in healthcare premises, 1994.
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- 28 to 29 –
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Health Technical Memoranda published by HMSO can be purchased from HMSO bookshops in London (post orders to PO Box 276, SW8 5DT), Edinburgh, Belfast, Cardiff, Manchester, Birmingham and Bristol, or through good booksellers. HMSO provide a copy service for publications which are out of print; and a standing order service.

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